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Arab Regional Systems of Innovation: Characteristics and Implications

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Arab Regional Systems of Innovation: Characteristics and Implications

By Dr. Samia Satti Osman Mohamed Nour

(October 10, 2010)

Arab Regional Systems of Innovation: Characteristics and Implications

By Dr. Samia Satti Osman Mohamed Nour[1]

(October 10, 2010)

Abstract

This paper employs both the descriptive and comparative approaches and uses the definition of systems of innovation used in the literature to discuss the systems of innovation in the Arab region. We explain that the two common characteristics of poor Arab regional systems of innovation is apparent from both the poor subsystems of education, S&T and R&D and ICT institutions across the Arab countries and the heavy concentration of R&D activities within both public and universities sectors and very limited small contribution of the private sector in R&D activities. We find that the major implications are the poor performance of the Arab region in terms of S&T indicators, local technological capabilities, technology achievement index, increasing technological and knowledge gap and distance between the Arab region and the other advanced regions in the world and poor integration in the global knowledge economy. Therefore, the major policy implication from our analysis is that it is essential for policy making in the Arab region to confirm commitment to enhance the institutions and systems of higher education, S&T, R&D, technological infrastructure, ICT and scientific cooperation to build the Arab regional systems of innovation and to achieve economic development in the Arab region.

Key words: Education, S&T, R&D, Systems of innovation, Arab region.

JEL classification: O10, O11, O30

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Arab Regional Systems of Innovation: Characteristics and Implications

1. Introduction

This paper aims to discuss the characteristics, constraints and implications of the regional innovation systems in the Arab countries and to contribute to recently emerged research studies aim to improve understanding of the nature and performance of regional innovation system in the developing countries.[2] We provide an overview of the innovation system in the Arab region, and explain that the regional system of innovation is characterized by serious weaknesses in the Arab countries compared with other regions in the world. The Arab region is manifestly lagged behind other advanced regions in the world in term of knowledge, skills, technological capabilities, spending on ICT, competitiveness, integration in the world economy and average growth rate. The poor performance leads to insignificant share of Arab states in the global economic system, poor technology achievement index and capacity to create knowledge.

Our analysis to aims to provide a comparative assessment and more in-depth overview of the constraints and implications of the poor system of innovation across Arab countries according to certain criterion, mainly the classification of the Arab countries according to income level. The selection of this criterion is quite consistent with the conventional view concerning the positive relationship between knowledge necessary for building efficient systems of innovation and development/income level, since knowledge and hence efficient innovative capabilities are concentrated in high income and developed countries as indicated in numerous studies (cf. UNESCO, 2004a; World Bank, 1999; OECD European Second Report on S&T Indicators, 1997).[3] Moreover, our analysis is interesting to contribute to the recent efforts aim to enhance Arab innovation system by improving understanding and awareness regarding the need for enhancing efficient institutions necessary for building system of innovation and enhancing economic development in the Arab countries.

We argue that the Arab countries are falling far behind other world regions and meantime, demonstrating a remarkable heterogeneity and non-homogenous performance with respect to systems of innovation, in particular, subsystems of higher education, S&T, R&D, information (ICT) and networking. Our analysis implies that across Arab countries, not only we observe remarkable diversity with respect to country size, demographic composition (population size), economic growth (per capita income/income level), structure of the economy and labor markets, human development indicators, but also we realize considerable heterogeneity affecting the systems of innovation. The later mainly related to remarkable

[2] The Arab region is composed of twenty two countries, including Algeria, Bahrain, Comoros, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libyan Arab Jamahiriya, Mauritania, Morocco, Oman Occupied Palestine Territories, Qatar, Saudi Arabia, Somalia, Sudan, Syrian Arab Republic, Tunisia, United Arab Emirates and Yemen

[3] For instance, the OECD (1999) indicates two sources of diversity in national innovation systems: a first source of diversity is country size and level of development. Large and highly developed countries offer markets with advanced customers and opportunities to reap economies of scale while maintaining diversity in R&D activities. A second source relates to the respective roles of the main actors in innovation processes (firms, public and private research organisations, and government and other public institutions), and the forms, quality and intensity of their interactions. (OECD, 1999: 22)

heterogeneity with reference to the subsystems of education, skill and training institutions, S&T and R&D institutions, technological capabilities and information (ICT) and networking institutions across the Arab countries. Therefore, our aim is to show the characteristics of Arab regional system of innovation along with this heterogeneity and its relationship with the level of income, in particular, high, medium and low levels of income across Arab countries, next we explain the major implications of the poor system of innovation. We discuss the differences in institutions or subsystems necessary for building regional innovation system in the Arab region; mainly we examine and compare the diversity in three subsystems of education, S&T and R&D and information or ICT institutions across the Arab countries. In particular, we examine whether the level of income has significant effect in building innovations system in the Arab countries.

Our classification of Arab countries according to the World Bank classification of economies according to the levels of income differs from the existing studies covering the Arab region and interesting to add new aspects. Particularly because several studies in the literature use different classifications of Arab countries for instance according to the structure of the economy (cf. Ali, 2004; ERF, 1998) and/or the geographical location in Asia and Africa (cf. UNESCO, 2004) in the Gulf or Mediterranean (cf. Nour, 2003; 2005). Moreover, our analysis uses most recent information and is a more comprehensive compared to the very few studies of the system of innovation in the Arab region (cf. Djeflat, 1999). Hence, this paper is interesting as it integrates the systems of innovation with the level of development/income and presents a new and more comprehensive analysis for the Arab region. To elaborate our argument we integrate the most widely used indicators of the systems of innovation utilizing the most update data from different sources. Similar to the studies in the literature, we define the system of innovation by subsystems including the higher educational and training institutions, S&T institutions defined by S&T input-output indicators (R&D, patent and publication), and information and institutions (ICT: population accessing the Internet, telephone and mobile). Moreover, we use other indicators such as technological capabilities or the ability to create basic and high technology infrastructures, technological structure of manufacture exports, mainly high-technology exports.

One major limitation of our analysis in this paper is related to the relevance and implications of the systems of innovation described in the literature to the analysis of Arab region as part of developing countries (cf. Shulin, 1999). We are aware of the conceptual and methodological difficulties of applying the systems of innovation approach of the developed countries to the developing countries. We believe that due to limited studies focusing on the developing countries (cf. Shulin, 1999; Muchie, Gammeltoft, and Lundvall, 2003) the available literature still provides useful insights for our purpose and analysis in this paper, mainly because of special emphasis on institutional settings for enhancing efficient systems of innovation. The second limitation is related to the limited scope of our analysis, since our aim is to explain only the characteristics and implications of Arab regional innovation system by investigating the subsystems of educational institutions, S&T and R&D institutions and information (ICT) institutions. While we admit that it is also essential to investigate the linkage and interaction between these Institutions, however, due to scarcity of necessary information, our analysis will not cover the interaction between

these institutions; we leave that for more in-depth analysis in the future. The third limitation of our analysis is related to scarcity of an updated information and data for some variables used in our analysis. Apart from these limitations our paper is useful to improve understanding of the characteristics and implications of Arab regional systems of innovation.

The rest of this paper is organized in the following way: We first present the literature dealing with the concept, definition and significance of regional systems of innovation in Section 2. Next in Section 3, we show and compare the general socio-economic and development characteristics of countries in the Arab region. We then discuss the characteristics and implications of Arab regional systems of innovation- defined by the subsystems including educational institutions, S&T and R&D institutions and information (ICT) institutions- and compares between the Arab countries and between them and other advanced and innovative regions in Section 4. In Section 5, we explain the major implications of the systems of innovation in the Arab region. Finally, in Section 6 we provide the conclusions and policy recommendations to improve the system of innovations in the Arab region.

2. Definition and significance of the concept of the systems innovation in the literature

More recently, the concept of the systems of innovation has been increasingly used in the recent literature to comprehend various kinds of systems of innovation. Before analyzing the Arab regional system of innovation, it is convenient to show briefly the literature that investigates more extensively the meaning and significance of the concept of systems of innovation. Much of this literature was addressing the national approach, while several studies also examine different approaches of the systems of innovation from the sectoral, local and regional perspectives.

The term 'national systems of innovation' has been widely used in the recent literature to reflect the interrelationship between technical and institutional change. Early contribution by Freeman (1987) defines a national system of innovation as 'the network of institutions in the public and private sector whose activities and interactions initiate, import, modify and diffuse new technologies' (Freeman, 1987: 1). Next pioneering contribution by Lundval (1992) provides a more clear and comprehensive definition of the concept of a national system of innovation. Lundval (1992) definition includes "all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring- the production system, the marketing system of finance present themselves as subsystems in which learning take place. A definition of the system of innovation must be kept open and flexible regarding which subsystems should be included and which processes should be studied. Determining in detail which subsystems and social institutions should be included, or excluded, in the analysis of the system is a task involving historical analysis as well as theoretical considerations…." (Lundval, 1992, 12, 13). Lundvall (1992) attempted a theoretical approach to link the national systems of innovation approach to innovation theory "one aim of this book is to demonstrate the need for developing an alternative to the neoclassical economics tradition by placing interactive learning and innovation at the center of analysis" (Lundvall, 1992:1). Next contribution by Nelson (1993) provides an empirical analysis of the national

systems of innovation approach.

Next Freeman and Soete (1997) argue that "The many national interactions (whether public or private) between various institutions dealing with science and technology as well as with higher education, innovation and technology diffusion in the much broader sense, have become known as 'national systems of innovation'. A clear understanding of such national systemic interactions provides an essential bridge when moving from the micro- to the macro- economics of innovation. It is also essential for comprehending fully the growth dynamics of science and technology and the particularly striking way in which such growth dynamics appears to differ across countries". (Freeman and Soete, 1997: 291).

All the definitions of the systems of innovation approaches seem to be consistent and in agreement with respect to highlighting the vital role of institutions in determining or influencing innovation. Lundavall (1992) argues that " 'the structure of production' and 'institutional set-up' are the two most important dimensions, which 'jointly define a system of innovation….. the institutional set-up … is the second important dimension of the system of innovation' " (Lundvall, 1992:9, 10). In analogous manner Nelson (1993) mentions organizations supporting R&D, Nelson and Rosenberg stress (1993) 'the institutions and mechanisms supporting technological innovation' (Nelson and Rosenberg, 1993:1). Moreover, the OECD (1999) also provides definition of the concept National Innovation System (NIS) "according to Metcalfe (1995) National innovation systems are defined as the "… set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provide the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies" (Metcalfe, 1995). Furthermore "the innovative performance of an economy depends not only on how the individual institutions (e.g. firms, research institutes, universities) perform in isolation, but also on "how they interact with each other as elements of a collective system of knowledge creation and use, and on their interplay with social institutions (such as values, norms, legal frameworks)" (Smith, 1996)" OECD, 1999: 24)

According to Edquist (1997) "innovation processes are influenced by many factors; they occur in interaction between institutional and organizational elements which together may be called 'systems of innovation'…. It is considered by many to be useful and promising analytical tool for better understanding innovation processes as well as the production and distribution of knowledge in the economy. It also provides an appropriate framework for the empirical study of innovations in their contexts. Furthermore, it is highly relevant from an innovation policy- making point of view". (Edquist, 1997:xiii).

According to the OECD (1999) the market and non-market institutions in a country that influence the direction and speed of innovation and technology diffusion can be said to constitute a national innovation system. The OECD, (1999) stresses the analysis and policy implications of the systemic approach based on the notion of the national innovation system. Such analysis implies that NIS is a tool for policy analysis, it helps defines the tasks of governments in promoting innovation-led growth, by emphasising that governments have a responsibility for improving the institutional framework for

knowledge exchange among firms and between market and non-market organisations. (OECD, 1999: 21-23)

There is considerable debate in the literature about focusing the analysis of the system of innovation at national rather than other scales, mainly, due to the fact that remarkable differences in institutional set-up, investment in R&D, and performance, may cause notable differences between various national systems between countries. In addition to the importance of national systems of innovation to secure the importance of political and policy aspects of process innovation as most public policies influencing the innovation system or the economy as a whole are still designed and implemented at the national level. (Edquist, 1997:12). Moreover, the OECD (1999) indicates that "innovation systems also exist at other levels, e.g. there are world-wide, regional or local networks of firms and clusters of industries. While, these systems may or may not be confined within a country's borders, but national characteristics and frameworks always play a role in shaping them. This also holds true with regard to the internationalisation of innovative activities, which to a large extent reflects foreign investors' perception of the relative strength of national innovation systems. Major advantage of the concept of an NIS is that it provides a tool for analysing country specificities in the innovative process in a globalised economy, as well as a guide for policy formulation. It highlights interactions and interfaces between various actors and the workings of the system as a whole rather than the performance of its individual components (Lundvall, 1992)". (OECD, 1999: 23)

Many studies in the literature concentrate on the national approach, while several studies also examine different approaches of the systems of innovation from the sectoral, local and regional perspectives; The OECD (1999) for instance, identifies different but complementary approaches of NIS analysis at the micro, meso and macro levels. Nelson and Rosenberg (1993: 5) implicitly argue for a sectoral approach, then inquiry the usefulness of examining the national systems of innovation. Because of increasing internationalization, Lundvall (1992:3-4) also expresses arguments against studying systems of innovation from a national perspective. Therefore, the concept national is discussed and examined along with other systems of innovation including supranational; global, local or regional and sectoral approaches. (Edquist,1997:11).

The concept of 'regional innovation system' (RISs) reflects a regional perspective on innovation and industrial development, it has been developed since 1992 (see, for example, Cooke, 1992; 1996) from the contribution following the ((NSIs) literature (Lundvall, 1992; Nelson, 1993). One example is AnnaLee Saxenian's analysis of 'regional industrial system' which focus on Silicon Valley California and Route 128 Massachusetts (Saxenian, 1994). Despite, considerable debate in the literature on the existence of regional innovation systems (RISs) and meaningful of the idea of 'regional innovation'. For instance, Braczyk, Cooke and Heidenreich (1998) express argument for focusing on the Regional innovation systems (RISs), indicating that change in the organization of production, policies and business location also mean the regional level has grown in importance as a source of innovation support for business. They indicate the interaction between technology and regional development policies and increasing attention in explaining

the locational distribution and policy impact of regional high-technology industry that leads to the phenomenon of economically powerful "region-state". In addition to increasing interests to examine the extent of systemic innovation processes at regional level and the convergence or divergence among national innovation arrangements, particularly with the increasingly internationalization of science and technology and R&D, globalization and supranational innovation programmes. (Cooke, 1998: 2-6). Other studies in the literature provide similar two interpretations of increasing concern about regional system of innovation. "The first one is that local and regional government in Europe and the US are now more active in technology policy than they were 20 years ago. This new regionalism can be seen as a paradoxical consequence of globalisation- the growing importance of locality as a site for innovation. Regional innovation systems become an important issue because of increasing need in order to preserve competitiveness of regions in a rapidly globalized world and to attract high-technology firms from outside the regions, or to facilitate the transfer of knowledge to regional firms" (Meeus, Oerlemans and van Dijck, 2000: 192). "The second interpretation is related to the basic idea behind regional innovation systems that proximity makes specific resources more readily available. On the other hand, compared to relationships on a larger spatial scale, local relationships between firms and institutional actors (local universities and research laboratories) facilitates the utilisation of resources because of cultural homogeneity (Lundvall, 1992, Morgan, 1997)" (Meeus, Oerlemans and van Dijck, 2000: 192).

3. General socio-economic characteristics of the Arab region (1990-2002)

We begin with the general socio-economic characteristics of Arab region, Table 1 shows socio-economic and development characteristics (the country size, demographic composition (population size), economic growth (GDP per capita) and human development indicators, life expectancy, literacy rate, combined enrolment ratio and poverty rates) of countries constituting the Arab region.[4] Our classification of the countries in the Arab region into three groups is based on the World Bank classification of countries according to income level. On that basis the share of high, medium and low income groups in total Arab countries account for 18%; 59% and 23% respectively.[5] This classification implies that the majority of the Arab countries are amongst the medium and low income countries and characterizing by medium or low income level.

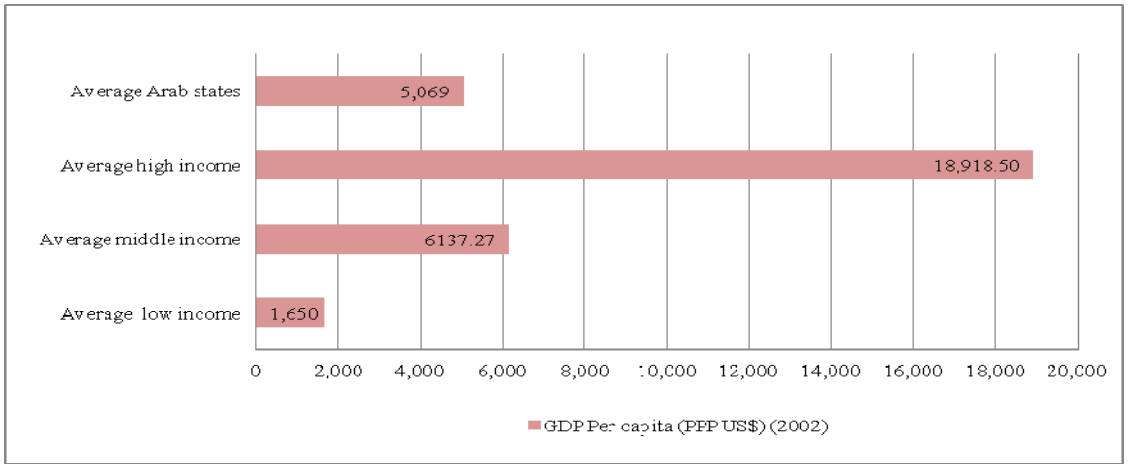
With respect to country size, from Table 1 we find that for the entire Arab countries, the total area of the region is 13488.65 thousand KM^2, the share of high, medium and low income groups in total area of the region accounts for 1%; 64% and 35% respectively. The total Arab population is accounting for 296.6 thousand million, the share of high, medium and low income groups in total Arab population accounts

[4] Fergany (1999) uses the term Arab region instead of Arab countries and argues that "in spite of recently efforts to define alternatives: "Middle East", MENA or "Arab countries, Iran and Turkey", an "Arab region" is a coherent and meaningful historical entity. It is also so in the perspective of science, especially social sciences. ……. "Arab Homeland", used in Arabic, is laden with cultural and functional connotations. The common language, an essential medium for knowledge generation and utilisation, is a potent reason. A distinguished history of achievement in science at the zenith of Arab civilisation is another".

[5] According to the World Bank classification (2005), the Arab high-income group includes only four countries: UAE, Qatar, Kuwait and Bahrain. Arab medium-income group includes thirteen countries: Saudi Arabia, Oman, Egypt, lgeria, Tunisia, Morocco, Syria, Lebanon, Jordan, Iraq, Libyan Arab Jamahiriya, Occupied Palestine Territories and Djibouti. Arab low-income group includes five countries: Sudan, Somalia, Yemen, Comoros and Mauritania.

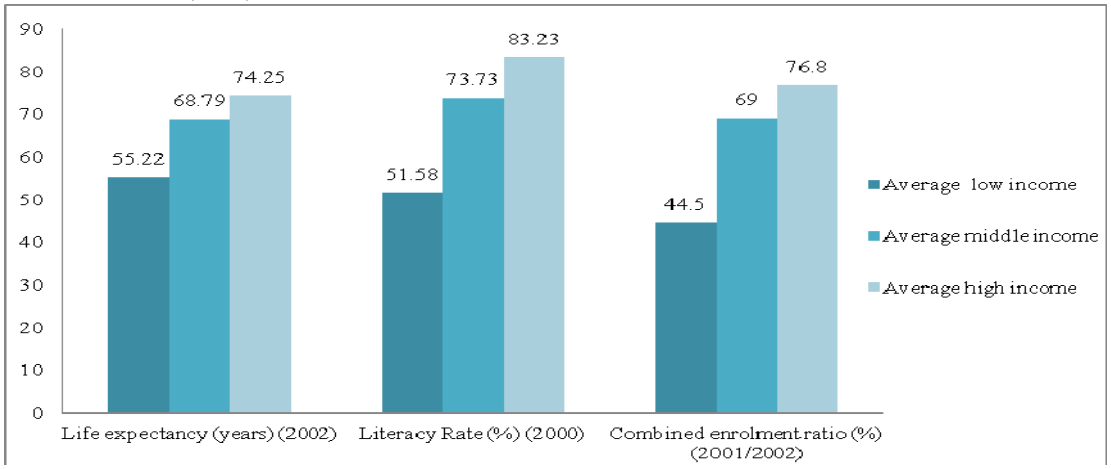
for 2%; 76% and 22% respectively. Concerning economic growth- as measured by GDP per capita, Figure 1 shows that the average GDP per capita for all Arab, high, medium and low income countries is amounting for US$ 5,069; US$ 18,918.5; US$ 6,137.27 and US$ 1650 respectively. Regarding HDI, the average for all Arab, high, medium and low income countries account for 0.65; 0.830; 0.70 and 0.50 respectively. Concerning life expectancy, the average for all Arab, high, medium and low income countries account for 66.3; 74.25; 68.79 and 55.22 respectively. With respect to literacy rate, the average for all Arab, high, medium and low income countries account for 63.3; 83.23; 73.73 and 51.58 respectively. With regards to combined enrolment ratio, the average for all Arab, high, medium and low income countries account for 60; 76.8; 69 and 44.50 respectively- See Figure 2 below. Furthermore, the high incidence of poverty is widely spread across all low and most of medium income Arab countries and accounts for 17.46 and 20.8-54.15 respectively, while, on the other hand, there are no reported figures for high income group.

Figure 1: GDP Per capita across Arab high, medium and low income countries (2002)



Source: Author calculation from the UNDP (2004)

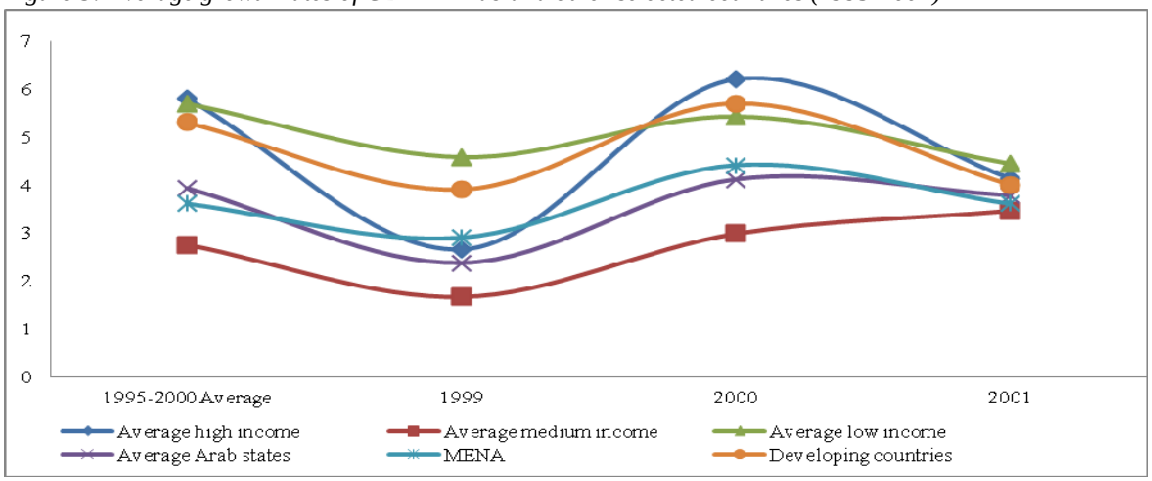
Figure 2: Life expectancy, literacy rate and combined enrolment ratio across Arab high, medium and low income countries (2002)



Source: Author calculation from the UNDP (2004)

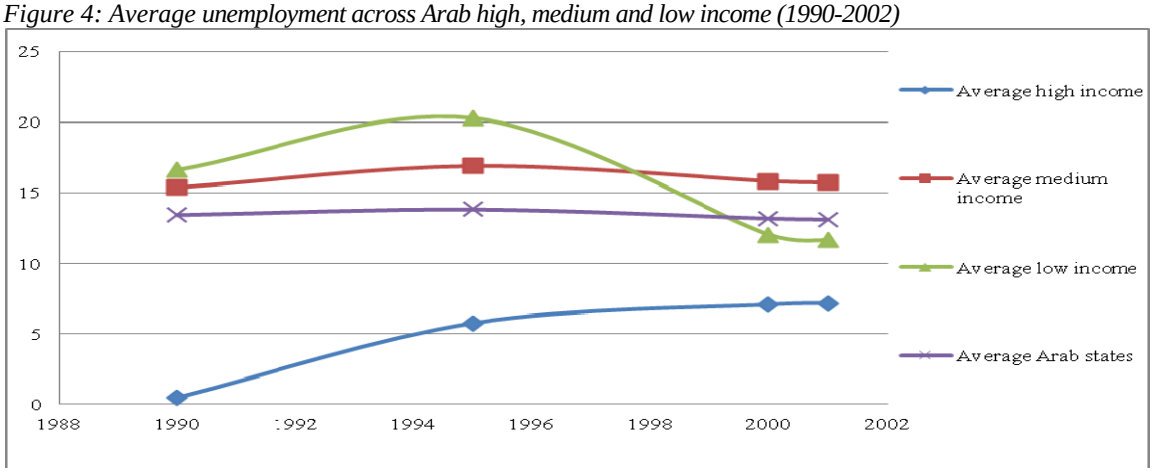
Moreover, according to the estimates of the World Bank-World Economic Outlook (2002), average unemployment rates are high but average trends show either slow increase or decline across low and medium income countries. While in contrast, average trends of unemployment rates show rapid increase across high income countries compared to medium and low income countries. In addition, the average trend of real GDP growth rate show considerable fluctuation across the Arab high, medium and low income countries, the average real GDP growth rate in the period 1995-2000 is higher for the high income group followed by the low and medium income respectively- See Figures 2-3 below.

Figure 3: Average growth rates of GDP in Arab and other selected countries (1995-2001)



Source: Adapted from the World Bank: World Economic Outlook (2002)

Figure 4: Average unemployment across Arab high, medium and low income (1990-2002)



Source: Adapted from the World Bank: World Economic Outlook (2002)

From the figures presented above, we observe the great diversity amongst the Arab countries in terms of country size, demographic composition and both socio-economic and development indicators (including GDP per capita, HDI, life expectancy, combined enrolment ratios and poverty rate).[6] From these findings,

[6] Fergany (1998) recognizes the diversity amongst Arab countries, in particular, the heterogeneity of Arab employment conditions and argues that "The Arab region comprises quite a heterogeneous group of countries, both in terms of socio-economic structure and the nature of unemployment. On one hand, the six oil-rich GCC countries are major labour importers. Having been, to varying

the major characteristics differ across the three groups, the high income countries are characterizing by smallest tiny size of area and population and high levels of income and socio-economic development indicators and rapid increase in average trends of unemployment rates. The medium income countries are characterizing by large size of area and population and medium levels of income and socio-economic development indicators and high unemployment rates. The low income countries are characterizing by medium size of area and population, low levels of income and socio-economic development indicators and high poverty and unemployment rates. All high income countries are clustered in the Gulf region and located in Asia, while, the location of both medium and low income countries are distributed between Asia and Africa, majority of low income are located in Africa. The Arab region is also marked by great geographical heterogeneity, the region is composed of twenty two countries, of which, twelve are located in Asia (West Asia: Bahrain, Iraq, Jordan, Kuwait, Lebanon, Oman, Occupied Palestine Territories, Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirates and Yemen). And ten in Africa (six in North Africa: Algeria, Egypt, Djibouti, Morocco, Libyan Arab Jamahiriya, Tunisia, and four in Sub-Saharan Africa Comoros, Mauritania, Somalia, Sudan).

Consequently, from Figures 1-2, the great heterogeneity in human development indicators across the Arab states can be interpreted in relation to variation of economic growth indicators/ income level, particularly GDP/ per capita. As we will investigate below that also holds for the disparities in the diffusion of ICT as measured by the percentage of population accessing the Internet, telephone and mobile.[7] On the other hand, Table 2 shows that although the level of economic growth and unemployment rates varied enormously across the Arab countries, however, now the Arab states are facing the challenges of declining trend of economic growth rates and increasing unemployment rates.[8] Moreover, the presence of high poverty rate adds to the challenging situation in the medium and low income groups in the Arab countries.[9]

As we will explain in this paper, despite, the great heterogeneity in economic and development indicators/performance across the Arab countries, however, it is evident that none of the Arab country presents sufficient, coherent and efficient institutions to build the system of innovation. While, the Arab high income Gulf states are leading the Arab states in terms of GDP per capita, human development indicators, spending and diffusion of ICT. However, they fail to present a coherent and convincing performance in the knowledge economy and efficient institutions to build the system of innovation due to

degrees, generous welfare states, these countries have been undergoing economic strains as a result of the declining fortunes of the international oil market. .... But about 90% of the Arab population reside in countries outside the GCC. This is also a very heterogeneous lot. On the human development index, in 1998, they include some at the top of the "medium" level countries as well as some near the bottom of the "low" tier" Fergany (1998). Ali (2004) uses the ERF (1998) classification of Arab countries and finds that "The Arab countries have very diverse characteristics in such areas as the structures of economies, level of development, geographical location and type of governance and institutions. To highlight the economic diversity of the region, ERF (1998) grouped the countries of the region into four broad categories: mixed oil economies (MOE: Algeria, Iraq and Libya); oil economies (OE), which include the countries of the Gulf Cooperation Council of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and UAE; diversified economies (DE: Egypt, Jordan, Lebanon, Morocco, Syria and Tunisia); and primary export economies (PEE: Comoros, Djibouti, Mauritania, Somalia, Sudan and Yemen)". (Ali, 1998: P. 11).

[7] See, for example, Nour 2002a).

[8] See Elbadawi (2002) and Makadisi et al. (2003) for recent analysis of slowing economic growth in the Arab world.

[9] For instance, the UNDP (2004) information in Table 1 shows that the percentage of population below income poverty line during the period (1990-2002) is estimated between <2% and 63.1% of total population. Moreover, the results of Ali (2001) and Ali and Elbadawi (2000) indicate the high incidence of poverty in the Arab states, estimating about 22% of the Arab population were living below a real poverty line measured in term of purchasing power parity price (PPP) of $ 56 per person per month.

the recent declining trend in growth rates coupled with increasing unemployment[10], insignificant economic impacts of ICT[11], failure to attract FDI, beside their failure to promote efficient educational system, local technological capabilities, skills and heavy dependence on foreign technologies[12].

4. Characteristics of Arab systems of innovation: education, science and technology (S&T) [13] and ICT Institutions

This section identifies two common characteristics of the Arab subsystems of innovation, we point out several problems and weaknesses associated with the systems of innovation approaches in the region. In particular we describe two common characteristics of innovation subsystems in the Arab region concerning the serious weaknesses and poor performance falling behind advanced region. The identification of the characteristic of common weakness will be useful to show the differences across the Arab countries and explain the heterogeneous degree of weaknesses of the subsystem across different Arab countries. Therefore, next we show remarkable diversity associated with the systems of innovation approaches across the Arab countries. In particular, we explain that the performance in the subsystems differs among the Arab countries according to pattern/structure or specification of economy, mainly level of development/income, specific institutional settings, policy priorities, etc. The sources of diversity can be explained in relation to the country size and level of development/income, diversity with respect to subsystem of education, information, ICT, S&T and R&D (public, university and private research institutions).[14] The regional systems of innovation of various Arab countries can be quite different, due to differences in the structure of higher education and amount of public resources or government expenditure devoted to higher education, R&D, S&T, ICT and differences in the performance in terms of technology development and diffusion. In addition, the institutions constituting the systems of R&D and hence innovation may be different in various Arab countries, e.g. public research institutes may be important for R&D in one country, while research universities may perform a similar function in another. But since it is evident that a common feature across all Arab countries is the weaknesses in technological capabilities, so, the Arab countries need to build scientific and technological infrastructure and institutions to enhance their NIS and interaction between them.

4. 1. Subsystem of higher educational institutions

The institutions of education/higher education show serious weaknesses in the Arab region. From Table 1 we observe that the literacy rates have been insufficient for the spread of knowledge within the Arab society, for instance, we realized that despite the relative decline in illiteracy rates, however, the illiterate population is approaching around 40% of total Arab population. Data from the UNDP (2004) indicates that

[10] For instance, the results of Wadi (2001) and Abdelkarim and Ibrahim (2001) indicate the declining growth rates and declining labour productivity in Kuwait and the UAE respectively.
[11] Pohjola (2002), Kenny and (2002) and Nour (2002b) show an insignificant impacts of ICT in developing countries.
[12] See, for example, Muysken and Nour 2006).
[13] For earlier analysis of S&T in the Arab region, see for example, Qasem (1998), Zahlan (1999, a; b) and Fergany (1999).
[14] These sources of diversity are indicated in the OECD (1999)

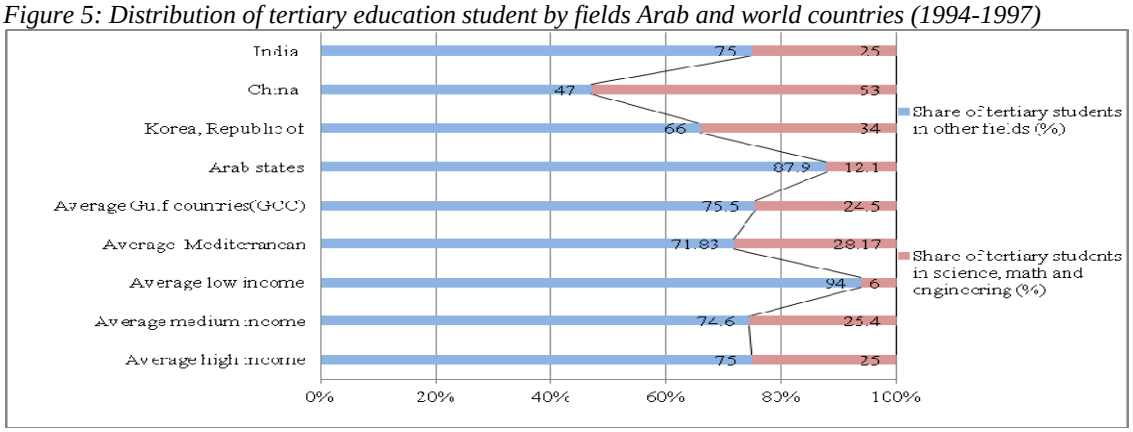
the illiteracy rates for all Arab countries together remain higher than the World total, LCD's, Asia, Latin America and the Caribbean and seem comparable to those of Africa and Sub-Saharan Africa. Moreover, Table 3 presents major skills indicators defined by the percentage share of gross enrolment ratio in tertiary education, the share of tertiary students in science, math and engineering and school life expectancy, beside, Harbison Myers Index, technical enrolment index and engineering enrolment index.[15] From Table 3 we find that the average percentages share of gross enrolment ratio in tertiary education (19.636) and the share of tertiary students in science, math and engineering (12.091) for all Arab countries together fall far behind Korea, Singapore Malaysia and China. We observe the variation across the Arab high, medium and low income groups, while, the average for high and medium are close to each other, but the gap between them and low income is high. Table 3 indicates that the average percentages share of gross enrolment ratio in tertiary education, the share of tertiary students in science; math and engineering and average school life expectancy in 2000 for medium income group exceed the high income group. Moreover, regarding other skill indices measured by Harbison Myers index, technical enrolment index and engineering enrolment index, the average for both high and medium income groups are near to each other, but there exists large differences between them and low income group. When comparing skill indicators between the individual high, medium and low income countries, we observe that at the individual level, the highest school life expectancy, gross enrolment in tertiary education and technical enrolment index are reported in two medium income countries rather than high income countries, while, the highest Harbison Myers Index and engineering enrolment index are reported in one medium income followed by high income countries.

With respect to higher educational system, we observe the problem of poor quality of education as major constraint for innovation system in the Arab region (cf. UNDP–AHDR, 2003). Moreover, Table 3 shows that for all Arab countries, while the average share of public spending on tertiary education as % of all levels increased in the period 1990-1995/97, the average declined during 1999-2001, the Arab region fall behind, Singapore, Malaysia and India. Table 3 explains another serious problematic feature of the tertiary education in the Arab countries is the (biases against) low share of tertiary students in science, math and engineering, with the exception of Algeria.[16] Moreover, Figures 5-6 show that according to the UNDP (2004), for all Arab countries average enrolment in sciences, math and engineering accounted only for 12.1% compared to 87.9% for other fields, the Arab region fall behind, Singapore, Malaysia and India, the enrolment ratios vary across Arab countries. Nour (2005) finds that the biases are more serious for the Arab Gulf compared to Arab Mediterranean countries. Furthermore, another problematic feature of higher education in the Arab countries appears from the relative distribution of tertiary education students by attainment levels. Figure 7 shows that on average, for the majority (83.8%) of tertiary students in the Arab region the attainment was less than the university degree, while only few (14.92%-1.29%) obtained the first university degree or higher, falling far behind China (48%) and Korea (41%).

[15] "Harbison Myers Index is the sum of secondary enrolment and tertiary enrolment times 5, both as % of age group. Technical enrolment index is tertiary total enrolment (times 1000) plus tertiary enrolment in technical subjects (times 5000), both as % of population. Engineering skills index is the same as previous index, with tertiary enrolments in engineering instead of enrolment in technical subjects" (Lall, 1999).

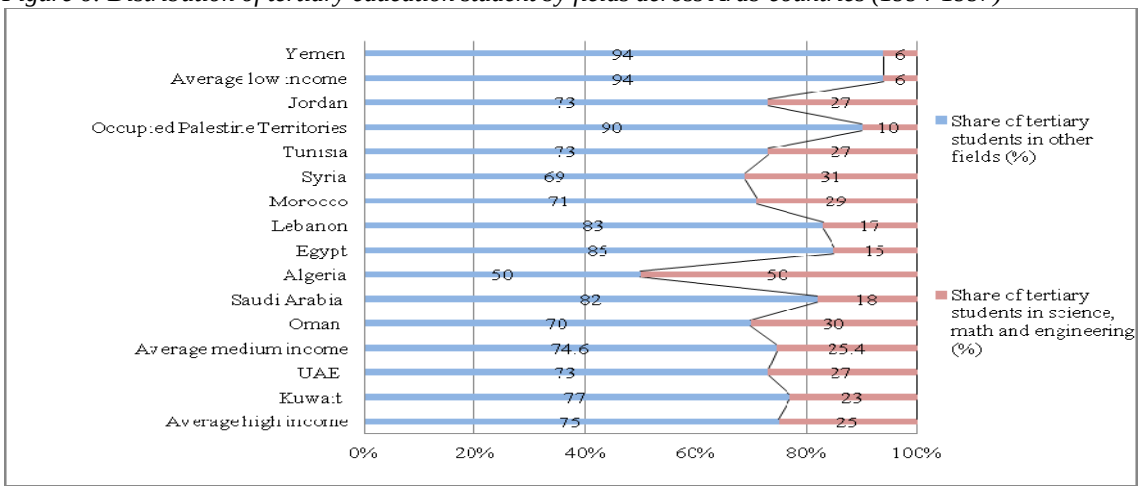
[16] See also Muysken and Nour (2006).

Figure 5: Distribution of tertiary education student by fields Arab and world countries (1994-1997)



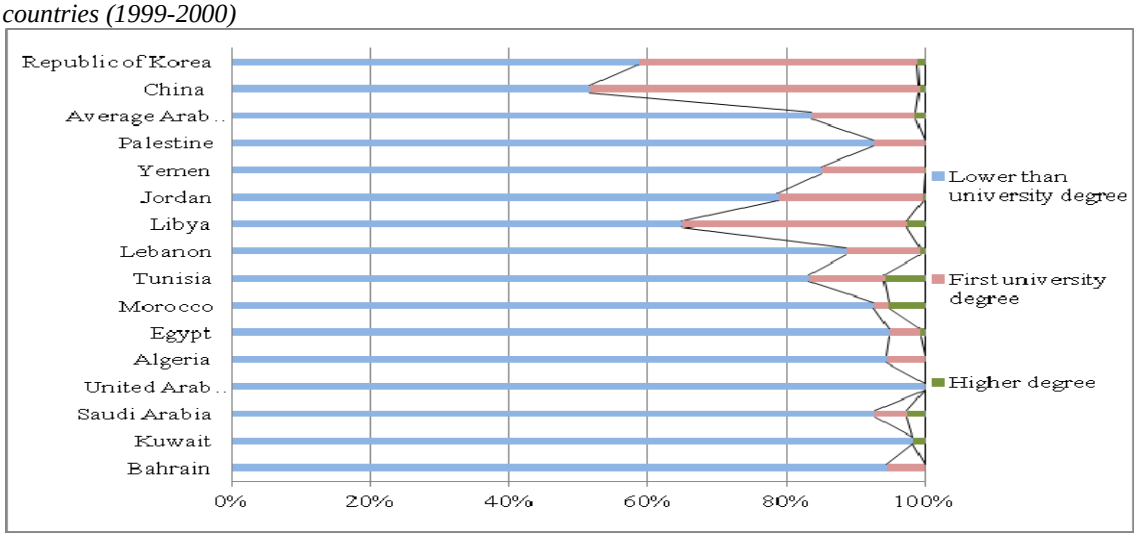
Sources: Adapted from the UNDP (2002; 2003; 2004)

Figure 6: Distribution of tertiary education student by fields across Arab countries (1994-1997)



Sources: Adapted from the UNDP (2002; 2003; 2004)

Figure 7: Relative distribution of tertiary education students by level of higher education Arab and World countries (1999-2000)

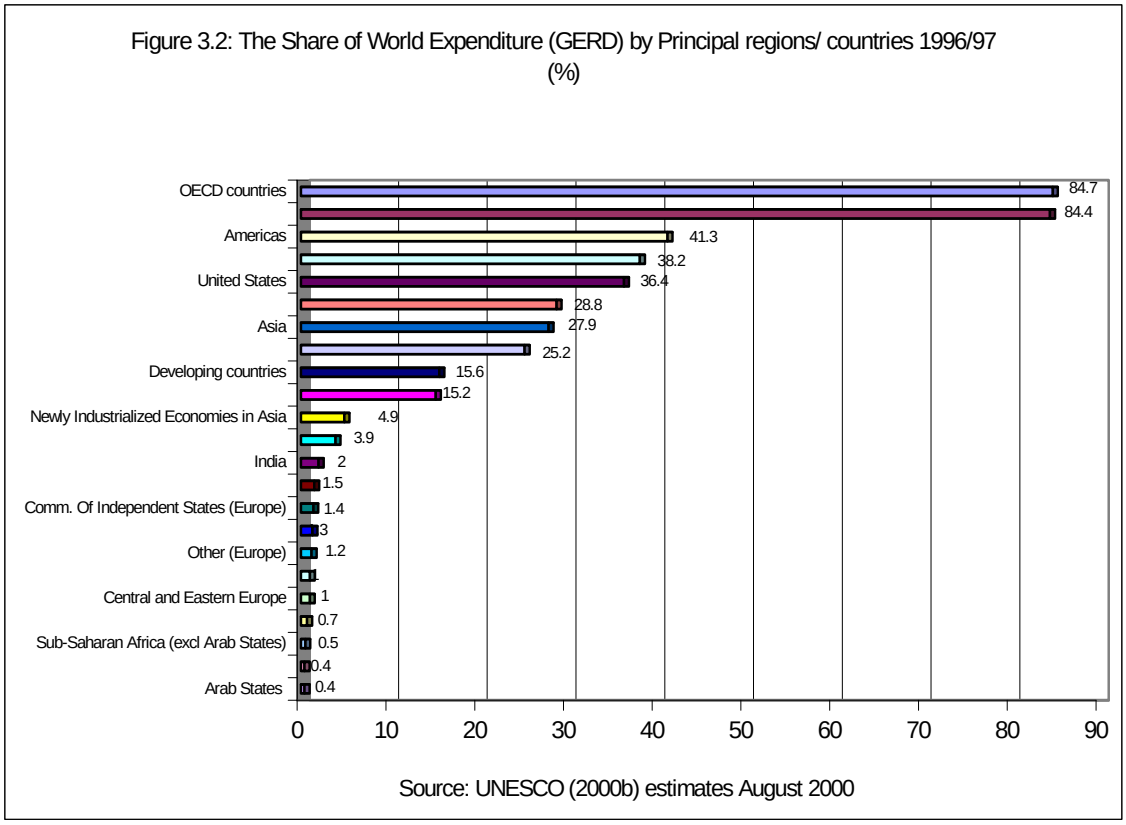


Source: Adapted from the UNDP – AHDR, 2003)

4. 2. Subsystem of science and technology (S&T) and R&D institutions

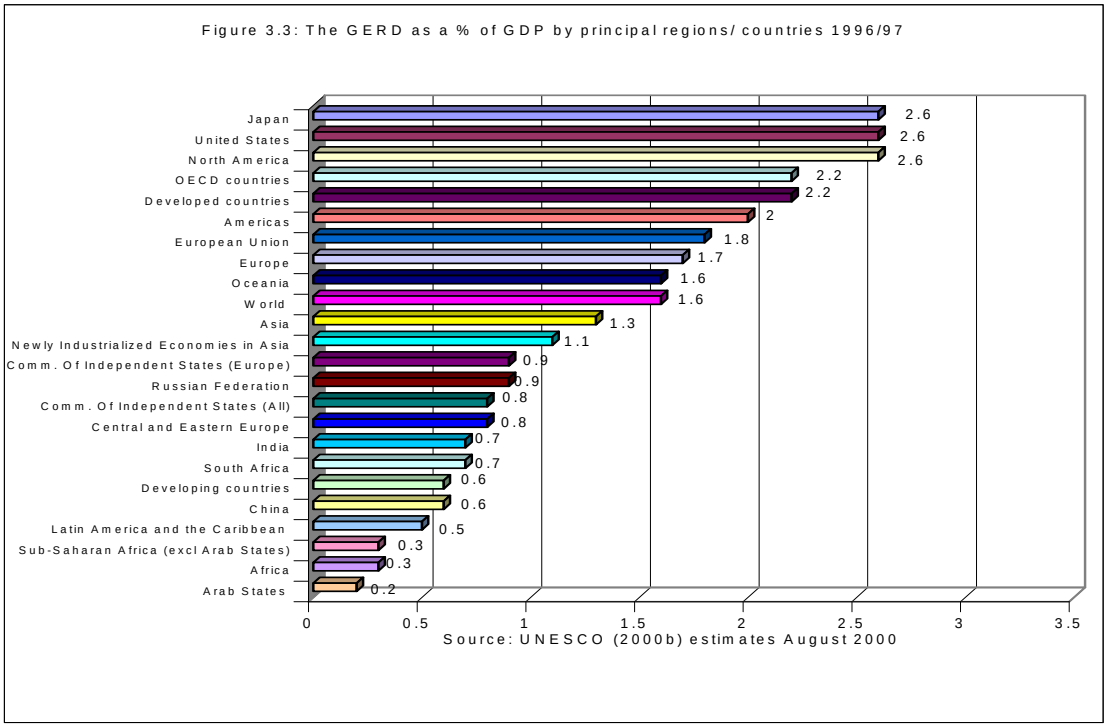
The institutions of S&T, mainly R&D institutions show remarkable serious weaknesses in the Arab region. For instance, the UNESCO (2004a) indicates that "Despite efforts to increase investment in R&D expenditures remain very low in developing countries. In 2000, developing countries spent 0.9% of their GDP on R&D, still falling short of the target of 1% mentioned in various S&T policy documents and international declarations for over 30 years. Nevertheless, there is considerable variation across countries. In the global picture the Arab states along with sub-Saharan Africa and the smaller Pacific islands, showed much lower levels of R&D expenditures compared to New Industrialized Economies of South East Asia, such as China and India and also compared to Latin America" (cf. UNESCO, 2004a). From Figure 8 we find that S&T input indicator measured by spending on R&D as percentage of GDP for all Arab countries together is accounting only for 0.4 of total World R&D expenditures, indicating that the Arab region is lagging far behind other world regions. Figure 9 indicates that the share of all Arab countries together is insignificant when seen from a global perspective, because it accounts for less than 0.5% of the world GERD, hence, lagging far behind not only advanced countries but also all other world regions, even Africa and Sub-Saharan Africa. In addition, Figure 10 illustrates an insufficient number of researchers in the Arab countries compared to both advanced and developing countries like China.

Figure 8: Share of World R&D Expenditures (GERD) by Principal regions/ countries (1996/97) (%)



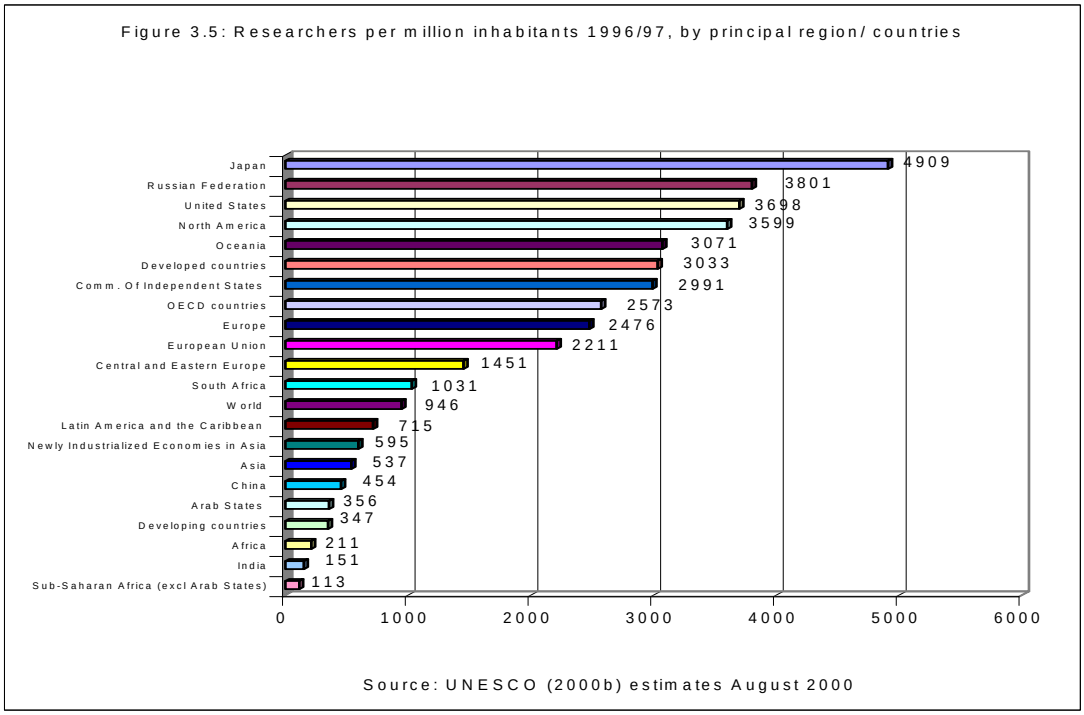
Source: UNESCO estimates August (2000)

Figure 9: GERD as % of GDP by Principal regions/ countries (1996/97)



Source: UNESCO estimates August (2000)

Figure 10: Researchers by principal region/ countries (per million inhabitants, 1996/97)

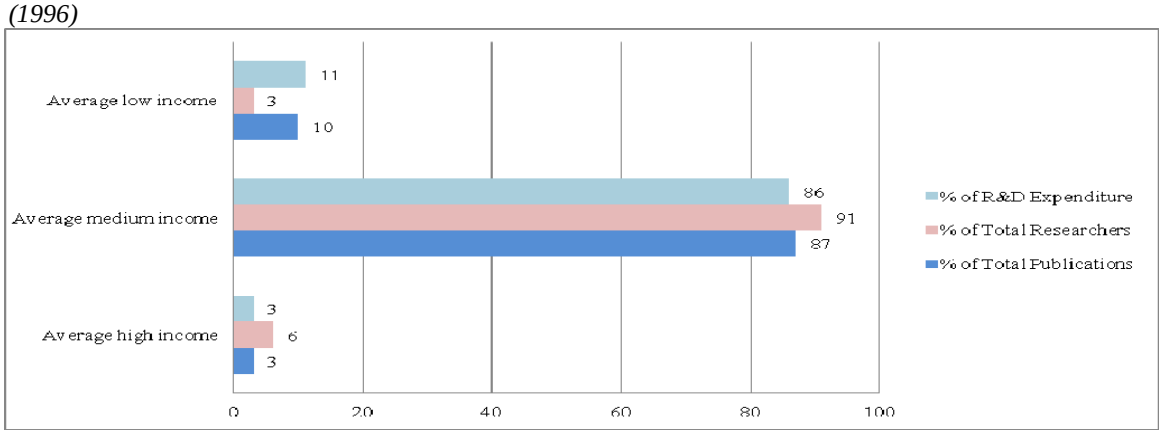


Source: UNESCO estimates August (2000)

We observe enormous variation between Arab high, medium and low income groups in terms of S&T input-output indicators, public spending on education as percentage of GDP and government expenditure, public spending on R&D as percentage of GDP, total number of researchers, S&E, patents and high technology exports. In 2001 the average public spending on education as a percentage of GDP for high, medium and low income account for 2.38%, 4.97% and 6.8% respectively, while as a percentage of government expenditure the average for high, medium and low income account for 11.4%, 15.05% and 32.8% respectively. In 1996-2002 the average public spending on R&D as percentage of GDP for high and medium income account for 0.09% and 1.24% respectively, while the total number of researchers, S&E in research in the high and medium income account for 803 and 3171 respectively. During the period 1991-1999 the total number of patents granted for high and medium income account for 44 and 147 respectively, while, the share of high-technology exports in total exports in 1997-2002 for high, medium and low income account for 3.5%, 29.2% and 7% respectively. These figures imply poor and insufficient human and financial resources devoted to S&T activities in the Arab region compared to other regions.

Moreover, we find considerable concentration of human and financial resources devoted to R&D in the Arab countries. For instance, in 1996 the average share of high, medium and low income in total Arab public spending on R&D account for 11%, 86% and 3% respectively. While, the average share of high, medium and low income in total number of Arab researchers account for 3%, 91% and 6% respectively. Therefore, it is not surprising that the average share of high, medium and low income in total publications account for 10%, 87% and 3% respectively- See Figure 11 below.

Figure 11: Distribution of total R&D expenditures, researcher and publications across Arab countries (1996)



Sources: Author calculation from ESCWA (1998) and UNDP –AHDR (2002)

Therefore, different from the conventional in the literature view that S&T development indicators show good performance in countries with high rather than medium income and development levels. It is somewhat surprising that with respect to all S&T input-output indicators in the Arab region the Arab medium income countries show higher performance than the Arab high income countries. It is somewhat surprising that the highest priority for public spending on education as percentage of GDP and total government expenditures is reported for a low income country exceeding the average levels for both high and medium income countries.

When comparing spending on education and S&T indicators between individual high, medium and low income countries we find enormous variation over the period 1990/1999-2001/2002. We observe that the public spending on education as a percentage of GDP is higher in Yemen, Saudi Arabia and Tunisia, followed by Morocco and Jordan, while, as a percentage of government expenditure is higher in Yemen and Jordan, followed by Tunisia, Bahrain, Lebanon and Syria. We observe that the public spending on R&D as percentage of GDP in 1996-2002 is higher in Jordan followed by Tunisia, while, the total number of researchers, S&E in research in 1990-2001 is higher in Jordan followed by Qatar, Egypt and Tunisia. Regarding S&T output indicators, we realize that the total number of patents in 1991-1999 is higher in Saudi Arabia followed by Egypt, Kuwait and Qatar, while, the high-technology exports in 1997-2002 are reported in Morocco followed by Sudan, Algeria and Tunisia. Therefore, at the individual level, the highest spending on R&D as percentage of GDP, the total number of researchers, S&E in research and total number of patents are reported in one or two medium income countries rather than high income countries. The highest public spending on education as percentage of GDP and total government expenditures and the high-technology exports are reported in one medium and one low income countries respectively rather than high income countries. These results indicate inconclusive relationship between income level and institutions aimed at promoting S&T development indicators required for building the innovation systems. They also imply the considerable diversity across Arab countries, but none of the Arab country posses adequate human and financial resources for S&T and display efficient national system of innovation.

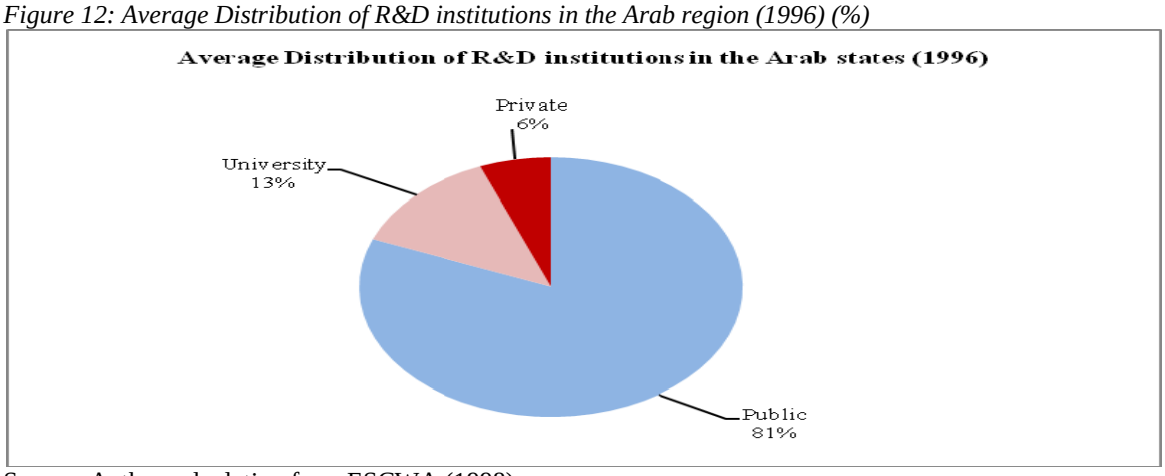
Furthermore, Table 5 illustrates the distribution of R&D institutional units by types, it indicates that public institutions are responsible from most of R&D activities and contribute by 81%, 77%, 66% and100% of total R&D institutions in all Arab, high, medium and low income countries respectively. Next to public sector, the universities sector contributes by 13% 10% and 28% of total R&D institutions in all Arab high and medium income countries respectively. While, the minor contribution comes from the private sector, which accounts only for 6% 13% and 6% of total R&D institutions in all Arab high and medium income countries respectively. The low and high income countries appear to be more dependent on the public sector compared to the medium income countries. Therefore, our results in Table 5 imply that most of R&D and hence, S&T activities in all Arab, high, medium and low income countries are mostly allocated within both public and university sectors. While, the private sector and hence, industry have only minor contribution in total R&D activities compared to public and university sectors.

Moreover, concerning human resources devoted to R&D, Table 5 shows the distribution of human resources available to R&D organizations, which is defined by the number of full-time equivalent researchers (FTE)[17]. Table 5 indicates that the majority of FTE researchers are employed by public and university sectors, for instance, the percentage share of FTE researchers in the public sector estimated at 70%, 66%, 69% and 76% of total FTE researchers in all Arab, high, medium and low income countries respectively. Next to the public sector, the percentage share of FTE researchers in the universities accounts for 28% 31%, 29% and 24% of total FTE researchers in all Arab, high, medium and low

[17] The concept of full – time equivalent researcher is adopted by UNESCO statistics on Research and Development (R&D) personnel.

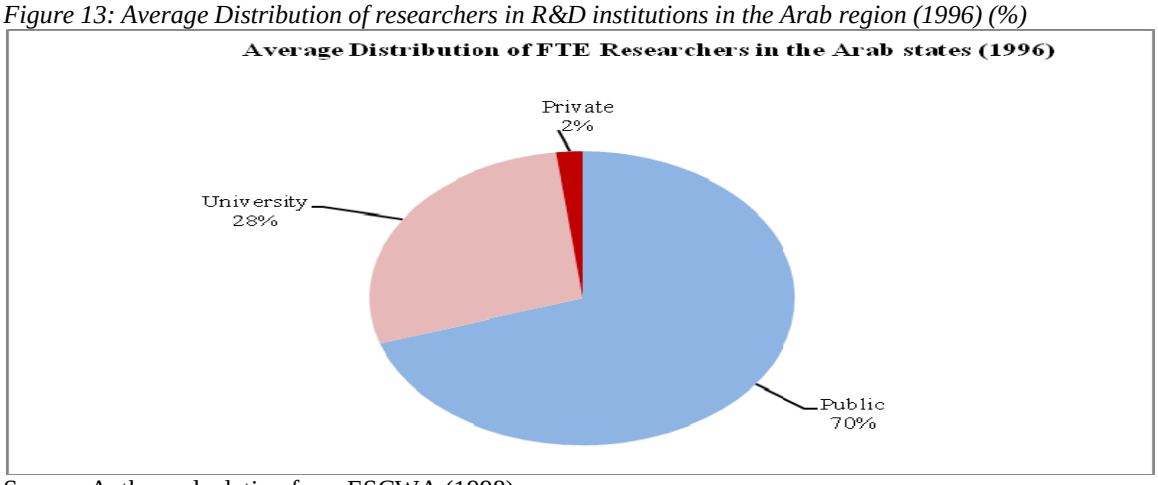
income countries respectively. While the percentage share of private sector is very marginal and accounts for 2%, 3% and 2% of total FTE researchers in all Arab, high and medium income countries respectively. The low and medium income countries appear to be little more dependent on the public sector compared to the high income countries. So, these results together with our results presented above imply the major share of both public and universities sectors and the minor contribution of the private sector in both R&D activities and FTE researchers in all Arab, high, medium and low income countries. Figures 12-13 imply that in the Arab region the share of public, university and private sectors in total R&D institutions and researchers in R&D institutions account for 81%, 13% and 6% and for 70%, 28% and 2% respectively.

Figure 12: Average Distribution of R&D institutions in the Arab region (1996) (%)



Source: Author calculation from ESCWA (1998)

Figure 13: Average Distribution of researchers in R&D institutions in the Arab region (1996) (%)



Source: Author calculation from ESCWA (1998)

In addition, the institutions constituting the systems of R&D and hence innovation may be different in various Arab countries, e.g. public research institutes may be important for R&D in one country, while research universities may perform a similar function in another. For instance, while all research activities are concentrated in the public sector in both Lebanon and Yemen, the university institutions perform all research

activities in Qatar. In both Bahrain and UAE research activities are shared but mostly concentrated in the public institutions (75% and 60%) followed by the university institutions (25%-40%) respectively. Kuwait shows different structure due to the role of private sector, the research activities are shared but mostly concentrated in the public followed by the private institutions 73% and 27% respectively. On the other hand, Saudi Arabia shows another difference as the research activities are shared but concentrated in the university followed by public and private institutions 39%, 57% and 4% respectively. Egypt indicates another difference as the research activities are shared but concentrated in the public followed by university and private institutions 75%, 16% and 4% respectively. While, Jordan shows another difference as the research activities are shared but concentrated in the public institutions, followed by similar contribution from university and private institutions 75%, 12.5% and 12.5% respectively.

With respect to S&T output indicator, our discussion includes only scientific publications and patent. Regarding S&T output indicator as measured by the number of scientific publications, when comparing the status of the high, medium and low income countries, our findings in Figure 11 indicate that the average share of medium income countries in total Arab publications is higher than the high and low income countries. This might be interpreted as a consequence of better performance of medium income countries compared to the high and low income countries in most of S&T input indicators, in particular, in terms of total expenditures on R&D, the number of R&D employees and R&D scientists and engineers. Earlier findings indicate that the average share of high, medium and low income in total Arab public spending on R&D account for 11%, 86% and 3% respectively, the average share of high, medium and low income in total number of Arab researchers account for 3%, 91% and 6% respectively. Therefore, it is not surprising that the average share of high, medium and low income in total number of publications account for 10%, 87% and 3% respectively. Within the medium income countries, the performance in both Egypt and Morocco are relatively high compared to other Arab medium, high and low income countries.

From Table 4 data on S&T output indicator measured by the number of patents awarded to firms and individuals, we find that the total number for some of the Arab countries falls far below world average and does not exceed similar figures from other developing countries. The poor performance and low patenting activities indicates the low innovative activities in the Arab countries compared to the advanced and developing countries, particularly China and Korea. Moreover, we realize that S&T output indicator measured by the share of high-technology exports in total exports in 1997-2002 for Arab region fall behind Singapore, Malaysia, Korea and China. Therefore, in terms of S&T input-output indicators the performance of Arab region is lower than the recently advanced countries such as Singapore, Malaysia, Korea and China

4. 3. Subsystem of ICT and networking institutions

The information or Information and Communication Technology (ICT) institutions show remarkable improvement, progress and increasing trends but still suffer from great weaknesses in the Arab region. From Table 6 when measuring the diffusion of ICT by the percentage of population accessing the Internet, telephone and mobile, we find that the average share of Arab population (per 1,000 people) with access to

Internet, telephone and mobile are accounting only for 28%, 81% and 85%. This implies an inadequate diffusion of ICT, which is obviously falling far behind the comparable percentages or ranges for the advanced countries and behind Singapore and Korea. Moreover, the status of ICT spending in the Arab region represented by Egypt and Gulf countries lag below the international level (cf. Nour, 2002b).

From Table 6 we observe an enormous variation and large gap across the Arab high, medium and low income groups in terms of ICT diffusion, in particular, the Internet users, telephone mainlines and cellular subscribers. With respect to the average share of high, medium and low income in total Arab Internet users in 2002 the average for high, medium and low income account for 81% 17% and 2% respectively. While, on average the average share of high, medium and low income in total Arab telephone mainlines in 2002 for high, medium and low income account for 68%, 27% and 5% respectively. Whereas, on average the average share of high, medium and low income in total Arab cellular subscribers in 2002 for high, medium and low income account for 78%, 16% and 6% respectively.

When comparing between high, medium and low income groups, we observe that the Internet users in 2002 is higher in the UAE and Bahrain, followed by Lebanon, Qatar, Kuwait, Oman, Saudi Arabia, Jordan and Tunisia. While, the telephone mainlines are higher in the UAE and Qatar, followed by Bahrain, Kuwait, Lebanon, Saudi Arabia, Jordan, Syria, Libya, Tunisia, Egypt and Oman. Whereas, the cellular subscribers are higher in the UAE and Bahrain, followed by Kuwait, Qatar, Jordan, Saudi Arabia, Lebanon, Morocco and Oman. Therefore, at the individual level, the highest Internet users, telephone mainlines and cellular subscribers are concentrated in the Arab high income countries followed by medium income countries, while the low income countries have low shares. These results are not surprising since the use of ICT is often related to income level as reported in several studies in the literature (cf. Nour, 2002a).

Moreover, despite, the increasing importance of networking between regional and international institutions as measured by scientific cooperation among scientists, however, the Arab regional system of innovation is characterized by the very limited scientific cooperation within and between the Arab countries. The geographical proximity and social homogeneity (sharing similar culture, language, etc.) have limited effect to encourage regional scientific cooperation within the Arab region. For instance, "Zahlan, (1999a), explains the very limited cooperation as indicated by the number of joint publications and co-authorship amongst scientists in both the Arab Gulf and Mediterranean countries. In particular, there is no significant cooperation amongst the Gulf countries scientists; for instance, figures indicate that scientific cooperation amongst Gulf countries accounts for less than 2 percent of their worldwide cooperation. Zahlan, (1999a) finds that in 1990, co-authorship within the Gulf countries was only 1.4 per cent of all co–authored papers; this increased to 3 per cent in 1995. The limited regional cooperation also holds for the Mediterranean countries. For instance, Zahlan (1999a) finds that "in 1995, of total publications of scientists in Algeria, Morocco and Tunisia, very surprisingly only 11% of the co-authored publication involved scientists from two Maghreb countries[18] and only one (of the 11) did not involve an OECD partner. In

[18] The Maghreb countries include Algeria, Morocco and Tunisia.

addition there is limited scientific cooperation and co-authorship of scientists between both Arab Gulf and Mediterranean countries and between them and other Arab countries. The Gulf countries cooperation with Arab scientists tends to be limited to fewer number of Arab countries, e.g., Egypt is the major partner, according to Zahlan (1999a), joint co-authorship with non Gulf Arab countries merely reflects the fact that Gulf countries universities employ professors from other Arab universities. The limited cooperation with other Arab scientists also holds for the Mediterranean countries, for instance, Zahlan (1999a) finds that the cooperation between Maghreb countries and other Arab scientists accounts only for 3% and 3.5% of total joint published papers in 1990 and 1995 respectively. (Zahlan, 1999a: p. 15)" (Nour (2005).

5. Implications of Arab regional systems of innovation

Based on the above results on the major weaknesses of Arab regional institutions necessary for promoting innovation system in the Arab region, in this section it is useful to explain the major implications of this weaknesses on the performance of Arab region with respect to competitiveness and integration in the global economy, technological structure of manufactured exports, technological capability building measured by the shares of basic and high technology infrastructure and technology achievement index (TAI). [19], [20]

We define the degree of competitiveness and integration in the global economy, using some indexes such as the ability to attract foreign direct investment, ability to create basic and high technology infrastructure, value added in manufacturing and value added per employee and the technological structure of manufactured exports as percentage of total manufactured exports, specially, the share of high-technology exports as percentage of manufacture exports. Using these indicators we find that the Arab states have poor performance and lagged far behind world countries in term of all these indicators.

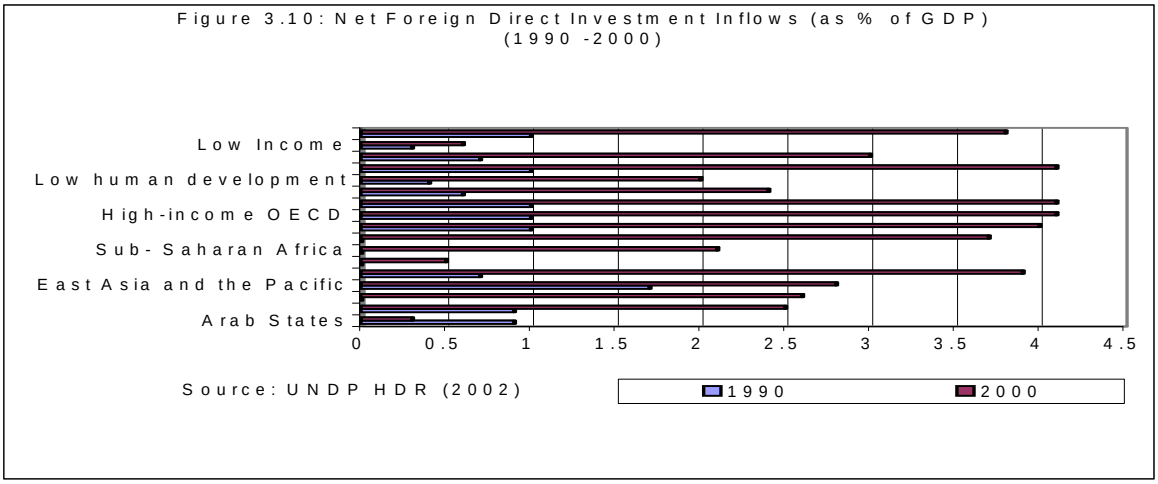
In this regard, the low ability to attract Net Foreign Direct Investment Inflows (NFDI) to the Arab region as compared to other regions in the world provides evidence for the low degree of competitiveness and integration in the global economy. For instance, Figure 14 shows that during the last decade the share of Arab states is accounting only for 1% of the regional distribution of the world NFDI as percentage of GDP (NFDI/GDP). In contrast to the increasing trends in NFDI/GDP amongst all other regions in the world, the trend for all Arab countries together shows an opposite declining trend. Hence, the share of all Arab countries together is insignificant when seen from a global perspective and lagging far behind not only the OECD,

[19] The results in this section are consistent with the findings of Haddad (2001), Lall (1999) and Belkacem (2002). For instance, Belkacem (2002), indicates that "despite the huge efforts made by many Arab countries in stabilizing and adjusting their economies as part of their economic reforms programs, their performance is unfortunately below their potential and are not taking full advantage of the opportunities that the global economy has offered to them. This is reflected in the weak record of Arab growth as compared to growth in LDC's. Low GDP growth rates coupled with high population growth rates meant stagnant per capita GDP growth rates. At the same time Arab Countries have attracted very little of net private capital which surged to LDC's in recent years. Arab exports growth which averaged only 1.5 % per annum during 1990-95 is far below LDC's performance where growth reached 10 % during the same period. Added to this slow growth of exports, most of it is made of traditional exports. These facts reflect that Arab countries are far from being prepared to face globalization challenges. Given their resource endowments Arab countries are under-achievers and are falling behind in an increasingly competitive world" (c.f. Belkacem (2002)).

[20] For definition and details about TAI see UNDP (2001). According to UNDP (2001), the technology achievement index (TAI) focuses on four dimensions of technological capacity that are important for reaping the benefits of the network age. TAI includes: (1) Creation of technology as measured by the number of patents granted per capita and receipt of royalty and licenses fees from abroad. (2) Diffusion of recent innovations as measured by diffusion of Internet and export of high and medium technology products as a share of all exports. (3) Diffusion of old innovations as measured by diffusion of telephone and electricity. (4) Human skills as measured by mean years of schooling and gross enrolment ratio of tertiary students enrolled in science, mathematics and engineering. (UNDP, 2001)

but also all other regions in the world and even LDC's, developing countries, Africa and Sub-Saharan Africa. Furthermore, the UNCTAD International Investment Report (2002) indicates that in 2001, the total amount of FDI attracted by all Arab countries together is less than the total amount attracted by Singapore alone, implying the low degree of attractiveness/competitiveness in the Arab countries. Moreover, the report indicates that within the Arab region only Bahrain is classified among the high performance country in terms of attracting FDI. While, the group of UAE, Syria, Oman, Lebanon, Qatar, Kuwait, Egypt and Saudi Arabia and the group of Libya, Morocco and Yemen are classified as low and very low attracting countries respectively.

Figure 14: Net Foreign Direct Investment Inflow (as % of GDP) (1990-2000)

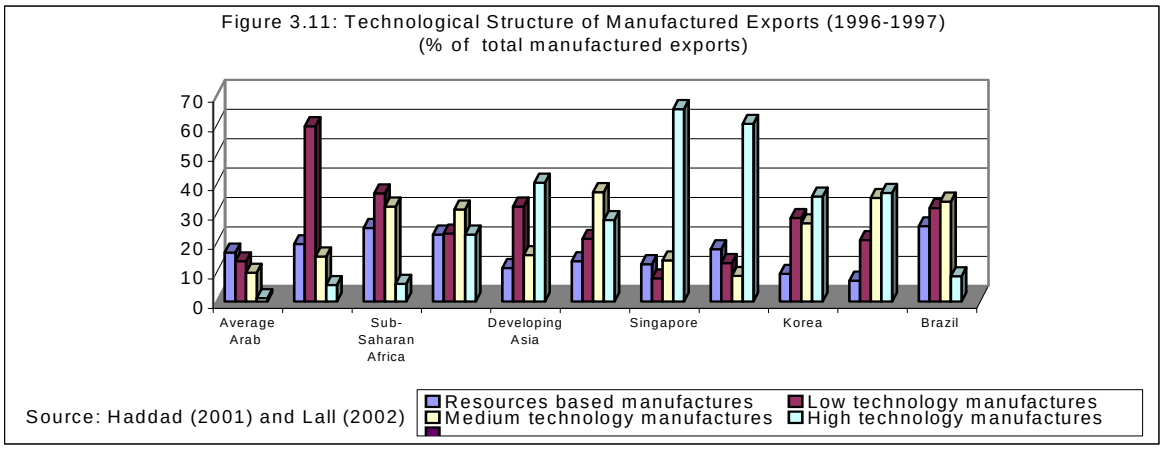


Source: Adapted from UNDP (2002)

Moreover, when we use the technological structure of manufactured exports as percentage of each country's total manufactured exports, particularly the share of high-technology exports[21] to define the degree of competitiveness in the technological market, we find further evidence for poor competitiveness of the Arab countries. For instance, Table 4 and Figure 15 show that the technological structure of manufactured exports as percentage of total manufactured exports in both Arab region and MENA region are dominated by both primary products and resources based manufactures. While the contribution of low, medium and high-technology manufactures is very marginal and insignificant. In particular, the share of high-technology manufactures for all Arab countries together is insignificant, insufficient and lagging far behind all world regions, including Singapore, Korea, Mexico and Brazil, LCD's, Latin America, Caribbean and Sub- Saharan Africa. That also holds for competitiveness in manufacturing in comparison with the developed and developing countries. For instance, the figures used in the study of Belkacem (2002) illustrate that the Arab countries are lagging behind the advanced countries and the leading developing countries such as China and Korea in terms of manufacturing per capita growth rate, the share of manufacturing activities in GDP, value added in manufacturing and value added per employee.

[21] Because of the significance of high- technology exports, many studies used high-technology exports to define the degree of competitiveness in the technological market.

Figure 15: Technological Structure of Manufactured Exports (1996-1997) (as % of total Manufactured Exports)



Sources: Adapted from Haddad (2001) and Lall (1999)

Furthermore, when we define the technological capability building by the shares of basic and high technology infrastructure, we observe that the shares of basic technology infrastructure is relatively higher than the shares of high technology infrastructure in the Arab countries.[22] From Table 7 we observe the variation across the Arab high, medium and low income groups in terms of basic and high technology infrastructure, on average basic technology infrastructure is higher in the medium income, while high technology infrastructure is higher in the high income group. With respect to the basic technology infrastructure in 1992 the average for high, medium and low income account for 0.968, 1.43 and 0.18 respectively, while, on average the high technology infrastructure in 1994 for high and medium income account for 0.17 and 0.16 respectively. However, Table 7 shows that the shares of both basic and high technology infrastructure in all Arab countries are inadequate for building the local technological capability and innovative systems and clearly lagging far behind the recently advanced countries such as Singapore, Korea and Hong Kong. Moreover, Table 7 indicates that also holds for the technology achievement index (TAI), as the Arab performance in terms of TAI falls far behind advanced and leading developing countries.

6. Conclusions

In this paper we present a comparative assessment and overview of institutions or subsystems necessary for building regional innovation system in the Arab region. In particular, we discuss and compare three subsystems of education, S&T and R&D and information or ICT institutions across the Arab countries.

We point out several problems related to the weaknesses of the systems of innovation approaches in the Arab region. In particular we identify two common characteristics of innovation subsystems in the Arab

[22] Rasiah (2002) defines basic technology infrastructure (BII) as weighted proxies representing basic education (enrolment in primary schools), health (physicians per thousand people) and communications (main telephone lines per thousand people). And defines high technology infrastructure (HII) as weighted proxies represents R&D investment in Gross National Investment and R&D scientists and engineers per million people. Rasiah (2002) argues that BII is an essential but not sufficient condition for economies to achieve technological capabilities, the incidence of economies generating innovation is higher when they also have the high technology support institutions, the lower BII the lower the capacity and resources for high technology development.

region concerning the serious weaknesses and poor subsystems falling behind the advanced regions. We find that the Arab region is manifestly lagged behind the other advanced regions in the world in term of knowledge, skills, higher education, R&D, S&T indicators, technological capabilities, spending and diffusion of ICT. The major implications are the declining average growth rate, insignificant share and integration of Arab region in global economy, poor technology achievement, competitiveness, increasing knowledge gap and distance between Arab region and other advanced region. We explain another common feature that most of R&D, researchers in R&D institutions and S&T activities in all Arab, high, medium and low income groups of countries are mostly allocated within both public and university sectors. While, the private sector and hence, industry have minor contribution in total R&D activities.

The identification of the characteristic of common weakness will be useful to show the differences across the Arab countries and explain the heterogeneous degree of weaknesses of the subsystem across different Arab countries. Therefore, next we show remarkable diversity associated with the systems of innovation approaches across the Arab countries. In particular, we explain that the performance in the subsystems differs among the Arab countries according to pattern/structure or specification of economy, mainly level of development/income, specific institutional settings, policy priorities, etc. The sources of diversity can be explained in relation to the country size and level of development/income, diversity with respect to subsystem of education, information, ICT, S&T and R&D (public, university and private research institutions). The regional systems of innovation of various Arab countries can be quite different, due to differences in the structure of higher education and amount of public resources or government expenditure devoted to higher education, R&D, S&T, ICT and differences in the performance in terms of technology development and diffusion. In addition, the institutions constituting the systems of R&D and hence innovation may be different in various Arab countries, e.g. public research institutes may be important for R&D in one country, while research universities may perform a similar function in another.

In investigating the institutions or subsystems necessary for building regional innovation system in the Arab region, we use a certain criterion, mainly the classification of Arab countries according to income level. We discuss the differences in institutions or subsystems necessary for building regional innovation system in the Arab region; mainly we examine and compare the diversity in three subsystems of education, S&T and R&D and information or ICT institutions across the Arab countries.

We observe the variation across Arab high, medium and low income groups concerning skills indicators defined by the percentage share of gross enrolment ratio in tertiary education, the share of tertiary students in science, math and engineering, school life expectancy, Harbison Myers Index, Technical enrolment index and Engineering enrolment index. We show enormous variation between high, medium and low income groups in terms of S&T input-output indicators, public spending on education as percentage of GDP and government expenditure, public spending on R&D as percentage of GDP, total number of S&E and researchers. We observe enormous variation across Arab high, medium and low income groups in terms of ICT diffusion, mainly, the Internet users, telephone mainlines and cellular subscribers, all ICT indicators are concentrated in the Arab high income countries followed by medium

income countries, while low income countries have only minimal contribution.

Our results are different from the conventional view in the literature that S&T development indicators show good performance in countries with high rather than medium income and development levels. From our results, it is somewhat surprising that with respect to all S&T input-output indicators in the Arab region, the average for Arab medium income countries show higher performance than the average for Arab high income countries. These results indicate considerable diversity but insignificant relationship between income level and institutions aim at promoting S&T development indicators required for building the innovation systems.

So, these results indicate that despite the great heterogeneous performance across the Arab countries, however, it was evident that none of the Arab country posses adequate human and financial resources for S&T, presents coherent performance to build an efficient system of innovation. While, the Arab high and Gulf countries are leading the Arab states in term of GDP per capita, human development indicators, spending and diffusion of ICT, however, they failed to build efficient institutions settings to enhance the innovation systems. Hence, it is evident that all Arab countries shared common characteristic concerning the weaknesses and failure to promote efficient educational system, skills, technological capabilities and infrastructure necessary for building systems of innovation.

Therefore, for building efficient innovative system, the countries in the Arab region need to create the most appropriate economic, political and scientific institutions, to build technological infrastructure and interactions between institutions. Mainly Arab countries need to improve the performance of educational and training systems, local and regional knowledge and S&T institutions, increase both financial and human investment to build local technological capabilities, particularly, basic and high technology infrastructure, ICT, skill levels and competitiveness. In addition to learning from the experiences of the other innovative regions to create a wider range of technological capabilities to promote efficient system of innovation and hence long- run harmonious development in the region.

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Appendix:

Table 1-General Socio-Economic Characteristics in the Arab countries (1990-2002)

Country	Area (thousand s KM^2)[a]	Total Populatio n (Million) (2002)[b]	GDP/per ncapita (PPP US $) (2002) b	HDI (%) (2002)[b]	Life Expectanc y (years) (2002)[b]	Literac y Rate (%) (2000)[b]	Combined enrolment ratio (%) (2001/2002) b	Population below income poverty line (%)[b]	
								$ 1 a day (1990-2002)[b]	$ 2 a day (1990-2002)[b]
Year	2001[a]	2002[b]	2002[b]	2002[b]	2002[b]	2000[b]	(2001/2002)[b]	(1990-2002)[b]	(1990-2002)[b]
High income	112.647	6.6	75,674	3.338	297	332.9	307.2	Na	Na
United Arab Emirates	83	2.9	22,420	0.824	74.6	77.3	68	Na	Na
Qatar	11	0.6	19,844	0.833	72.0	84.2	84.2	Na	Na
Kuwait	18	2.4	16,240	0.838	76.5	82.9	76	Na	Na
Bahrain	0.647	0.7	17,170	0.843	73.9	88.5	79	Na	Na
Average (total) high income	112.647	6.6	18918.5	0.830	74.25	83.23	76.8	Na	Na
Middle income	8673	228.21	67,510	8.443	894.3	884.8	897	3.2 - < 2	87.3
Oman	212	2.8	13,340	0.770	72.3	74.4	63	Na	Na
Saudi Arabia	1,961	23.5	12,650	0.768	72.1	77.9	57	Na	Na
Libyan Arab Jamahiriya	1,759	5.4	7,570	0.794	72.6	81.7	97	Na	Na
Tunisia	164	9.7	6,760	0.745	72.2	73.2	75	<2	6.6
Algeria	2,382	31.3	5,760	0.704	69.5	68.9	70	<2	15.1
Lebanon	11	3.6	4,360	0.758	73.5	86.5	78	Na	Na
Jordan	92	5.3	4,220	0.750	70.9	90.9	77	<2	7.4
Egypt	1,001	70.5	3,810	0.653	68.6	55.6	76	3.1	43.9
Morocco	447	30.1	3,810	0.620	68.5	50.7	57	<2	14.3
Syria	185	17.4	3,620	0.710	71.7	82.9	59	Na	Na
Occupied Palestine Territories	Na	3.4	Na	0.726	72.3	90.2	79	No infor.	No infor.
Djibouti	22	0.7	1,610	0.445	49.4	51.9	52	Na	Na
Iraq	437	24.51	Na	Na	60.7	Na	57	Na	Na
Average (total) middle income	8673	228.21	6137.27	0.700	68.79	73.73	69	<2	17.46
Low income	4,703	65.18	6,600	1.982	276.1	206.3	178	41.6	108.3
Sudan	2,506	32.9	1,820	0.505	55.5	59.9	36	Na	Na
Somalia	638	9.48	Na	Na	47.9	Na	Na	Na	Na
Yemen	528	19.3	870	0.482	59.8	49.0	53	15.7	45.2
Mauritania	1,031	2.8	2,220	0.465	52.3	41.2	44	25.9	63.1
Comoros	Na	0.7	1,690	0.530	60.6	56.2	45	Na	Na
Average (total) low income	4,703	65.18	1,650	0.500	55.22	51.58	44.5	20.8	54.15
Total/ Average Arab states	13488.65	296.6	5,069	0.651	66.3	63.3	60	25.9 - < 2	63.1- 7.4
Average (total) low income	4703	65.18	1,650	0.500	55.22	51.58	44.5	20.8	54.15
Average (total) middle income	8673	228.21	6137.27	0.700	68.79	73.73	69	<2	17.46
Average (total) high income	112.647	6.6	18918.5	0.830	74.25	83.23	76.8	Na	Na
% of high in total Arab	1%	2%							
% of medium in total Arab	64%	76%							
% of low in total Arab	35%	22%							

Sources: (a) CIA World Factbook (2001), (b) UNDP (2004).

Table 2 - Real GDP Growth and Unemployment in the Arab countries (1990-2002)

Country	Real GDP Growth (average annual change in percent)					Unemployment (in percent of total labor force)			
	1995-2000 Average	1999	2000	2001	2002 Projected	1990	1995	2000	2001
High income	23.2	10.6	24.8	16.5	6.9	0.5	11.5	14.1	14.3
Bahrain	4.3	4.3	5.3	4.8	4.1	Na.	10.0	12.0	12.0
Kuwait	3.8	-2.9	2.9	-0.6	-0.5	0.5	1.5	2.1	2.3
Qatar	9.4	5.3	11.6	7.2	3.0	Na.	Na.	Na.	Na.
UAE	5.7	3.9	5.0	5.1	0.3	Na.	Na.	Na.	Na.
Average high income	5.8	2.65	6.2	4.13	1.73	0.5	5.75	7.05	7.15
Medium income	30.3	18.3	32.8	38.1	31.1	76.8	84.5	79.1	78.6
Oman	3.6	-0.2	5.1	7.3	3.3	Na.	Na.	Na.	Na.
KSA	1.9	-0.8	4.9	1.2	0.7	Na.	Na.	Na.	Na.
Algeria	2.9	2.3	2.8	3.4	2.9	19.8	28.0	27.3	28.5
Egypt	5.3	6.0	5.1	3.3	2.0	8.6	9.6	7.9	7.6
Lebanon	2.3	1.0	-0.5	2.0	1.5	Na.	Na	Na	Na
Morocco	1.9	-0.1	1.0	6.5	4.4	15.4	16.0	13.7	12.8
Syria	3.0	-2.0	0.6	2.7	3.1	Na.	Na	Na	Na
Tunisia	5.1	6.1	4.7	5.0	3.8	16.2	16.2	15.5	15.0
Libyan Arab Jamahiriya	1.6	0.7	4.4	0.6	1.7	Na.	Na	Na	Na
Djibouti	-0.9	2.2	0.7	1.9	2.6	Na.	Na	Na	Na
Jordan	3.6	3.1	4	4.2	5.1	16.8	14.7	14.7	14.7
Average medium income	2.75	1.66	2.98	3.46	2.83	15.36	16.9	15.82	15.72
Low income	17.1	13.7	16.3	13.3	14.2	16.6	40.6	12	11.6
Sudan	6.3	6.9	6.9	5.3	5.0	16.6	14.6	12.0	11.6
Somalia	Na.	Na	Na	Na	Na	Na.	Na	Na	Na
Yemen	6.5	2.7	4.4	3.4	4.1	Na.	Na	Na	Na
Mauritania	4.3	4.1	5.0	4.6	5.1	Na.	26.0	Na	Na
Average low income	5.7	4.57	5.43	4.43	4.73	16.6	20.3	12	11.6
Average high income	5.8	2.65	6.2	4.13	1.73	0.5	5.75	7.05	7.15
Average medium income	2.75	1.66	2.98	3.46	2.83	15.36	16.9	15.82	15.72
Average low income	5.7	4.57	5.43	4.43	4.73	16.6	20.3	12	11.6
Total/ Average Arab states	3.92	2.37	4.106	3.77	2.9	13.41	13.83	13.15	13.063
MENA	3.6	2.9	4.4	3.6	3.4	12.7	13.8	12.7	12.6
Developing countries	5.3	3.9	5.7	4.0	4.2	NA.	NA.	NA.	NA.

Source: The World Bank World Economic Outlook (2002). September 2002; The World Bank; staff estimates. I/Simple Averages: nationals only for Bahrain.

Table 3 – Human capital and Skills indicators in the Arab countries (1992–2002/2003)

Country	Skill indices (1995)			Gross enrolment ratio (%) at tertiary education	Share tertiary students in science, math and engineering	School life expectancy	
	Harbison Myers Index [a]	Technical enrolment index [a]	Engineering enrolment index [a]	1998 [b] – 2002/2003 [d] (7)	1994-1997 [b]	1992 [c] 1998	2000 [c]
Arab high income	31.3	44	36.27	75	50	42.9	45.5
Bahrain	Na	Na	Na	21	NA.	13.5	13.0
Kuwait	19.10	36.49	30.57	21	23	7.0	8.7
UAE	12.20	7.51	5.70	10	27	10.6	10.7
Qatar	Na	Na	Na	23	NA.	11.8	13.1
Average high income	15.65	22	18.14	18.75	25	10.73	11.38
Medium income	126.1	229.4	161.8	300	254	58.9	115.7
Oman	8.95	5.35	4.44	7	30	NA.	8.7
Saudi Arabia	13.45	18.96	14.42	22	18	8.5	NA.
Algeria	11.65	31.14	21.55	15	50	10.4	12 (5)
Egypt	16.45	16.10	13.87	38	15	10.3 (3)	Na
Lebanon	21.60	46.89	34.60	45	17	Na	13 (5)
Morocco	9.55	23.73	11.46	10	29	Na	8 (6)
Syria	13.35	23.47	17.67	6	31	10	9 (5)
Tunisia	12.55	24.49	16.15	23	27	10.6 (4)	14
Occupied Palestine Territories	Na	Na	Na	31 (2001/2002)	10		13 (2001)
Libyan Arab Jamahiriya	Na	Na	Na	58 (2001/2002)	Na.	Na	16 (2001)
Jordan	18.55	39.27	27.64	31 (2001/2002)	27	9.1	13 (2001)
Iraq	Na	Na	Na	14 (2001/2002)	Na	Na	9(99)
Djibouti	Na	Na	Na	Na	Na.	Na	Na
Average medium income	14.01	25.49	17.98	25	25.4	9.82	11.57
Low income	10.8	13.38	10.83	23	6	3.4	24
Sudan	2.80	3.50	2.92	7 (98/99)	Na	Na	5 (98)
Yemen	4.45	4.60	4.17	11 (99/2000)	6	Na	8(98)
Mauritania	3.55	5.28	3.74	4 (2001/2002)	Na	Na	7
Comoros	Na	Na	Na	Na	Na	Na	Na
Average low income	3.6	4.46	3.61	6.75	6	Na	6.67
Arab states	12.01	20.48	14.92	19.636	12.091	9.625	9.875
Average high income	15.65	22	18.14	18.75	25	10.73	11.38
Average medium income	14.01	25.49	17.98	25	25.4	9.82	11.57
Average low income	3.6	4.46	3.61	6.75	6	Na	6.67
Arab states	12.01	20.48	14.92	19.636	12.091	9.625	9.875
Advanced Asia countries						2000	
Korea, Republic of	36.10	132.06	113.83	85 (1)	34%	15	
Singapore	23.05	48.81	44.76	24.2 (2)	Na	Na	
Malaysia	11.10	15.98	12.65	27	Na	12	
China	9.75	9.85	8.75	13	53	10	
India	8.10	11.85	7.18	11	25	9	

Sources: (a) Lall (1999) (b) UNDP (2002), (c) UNESCO (1999) and (d) UNESCO (2004b): www.unesco.org, most recent data on gross enrollment in tertiary education.

Note: (1) data refer to 2002/2003 (2) data refer to 1995/1997 (3) data refer to 1993, (4) data refer to 1991, (5) data refer to 1998, (6) data refer to 1999, (7) refer to most recent data on gross enrollment in tertiary education.

Table 4 – Science and Technology indicators in the Arab countries compared to World countries (1990–2002)

Country	Public expenditure on tertiary education as % of all levels [a,, d]			Public expenditure on education as % of GDP [a]		Public expenditure on education as % of government expenditure [a]		R&D Expenditures as % of GDP 1996-2000 [a]	Researchers (Scientists and Engineers) in R&D (per million population)	Patents [a, b] (1991-1999) [b] - 1999 [a]	High technology exports as % of manufactures exports [c]	
Year	1990 [a]	1995-97 [d]	1999-2001 [a]	1990	1999-2001	1990	1999-2001	1996-2002	(1990-2001) [a]	1991-1999 [b]	1985 [c] - 1999 [b]	1997 [c] - 2002 [b]
High income	16	30.2	Na	14.4	8.5	32.6	11.4	0.34	803	44	9.3	3.5
Bahrain	Na	Na	Na	4.2	3.0	14.6	11.4	0.06	NA	2 [b]	0.6 [c] (1)	1.5 [c] (5)
Kuwait	16	30.2	Na	4.8	Na	3.4	Na	0.20	212	27 [b]	3	..
UAE	Na	Na	Na	1.9	1.9	14.6	Na	0.02	NA	15 [b]	5.6 [c] (4)	2 (2)
Qatar	Na	Na	Na	3.5	3.6	Na	Na	0.06	591	0 [b]	0.1 [c] (4)	0
Average high income	16	30.2	Na	3.6	2.83	10.87	11.4	0.09	803	44	9.3	3.5
Medium income	110.1	166.6	76.5	42.4	39.8	134.5	60.2	7.41	3171	147	6	29.2
Oman	7.4	7	1.8	3.1	4.2	11.1	Na	0.07	4	3 [b]	2	2
Saudi Arabia	Na	16.2	Na	6.5	9.5	17.8	Na	0.14	NA	103 [b]	0.1 [c] (4)	0.2 [c] (5)
Algeria	Na	Na	Na	5.3	Na	21.1	Na.	Na	Na	Na.	0.0 [a] (4)	4 (3)
Egypt	Na	33.3	Na	3.7	Na	Na	Na	0.2	493	38 [b]	0.3 [a] (4)	1
Lebanon	Na	16.2	Na	Na	2.9	Na	11.1	Na	Na	Na.	..	3 (2)
Morocco	16.3	16.5	0.3	5.3	5.1	26.1	Na	Na	Na	Na	0.4 [c] (4)	11
Syria	21.3	25.9	Na	4.1	4.0	17.3	11.1	0.2	29	3 [b]	0.2 [c] (4)	1
Tunisia	18.5	18.5	21.7	6.0	6.8	13.5	17.4	0.5	336	Na.	2	4
Occupied Palestine Territories	Na	Na	Na	Na	Na	Na	Na	Na	Na	Na	Na	Na
Libyan Arab Jamahiriya	Na	Na	52.7	Na	2.7	Na	Na	Na	361	Na	0	..
Jordan	35.1	33	Na	8.4	4.6	17.1	20.6	6.3	1,948	Na	1	3
Djibouti	11.5	na	Na	Na	Na	10.5	Na	Na	Na	Na	..	..
Average medium income	18.35	20.825	19.125	5.3	4.97	16.81	15.05	1.24	3171	147	6	29.2
Low income	42.2	38.4	14.1	0.9	13.6	2.8	32.8			0	0	7
Sudan	Na	na	Na	0.9	Na	2.8	Na	Na	Na	0	..	7
Yemen	Na	na	Na	Na	10.0	Na	32.8	Na	Na	Na	..	..
Mauritania	24.9	21.2	14.1	Na	3.6	Na	Na	Na	Na	Na	0	..
Comoros	17.3	17.2	Na	Na	Na	Na	Na	Na	Na	Na	Na	Na
Average low income	21.1	19.2	14.1	0.9	6.8	2.8	32.8			0	0	7
Average high income	16	30.2	Na	3.6	2.83	10.87	11.4	0.09	803	44	9.3	3.5
Average medium income	18.35	20.825	19.125	5.3	4.97	16.81	15.05	1.24	3171	147	6	29.2
Average low income	21.1	19.2	14.1	0.9	6.8	2.8	32.8	Na	Na	0	0	7
Total/Average Arab	18.7	21.38	18.12	Na	Na	Na	Na	Na	Na	Na	..	2
Advanced Asia												
Korea, Rep. of	7.4	8.0	13.5	3.5	3.6	22.4	17.4	3	2880 (2,319) (1)	931 [a]	18	32
Singapore	29.3	34.8	Na	Na	3.7	Na	23.6	2.1	4,052 (4,140) (1)	12 [a]	40	60
China	Na	15.6	Na	2.3	2.1	12.8	Na	1.1	584 (545) (1)	b 793	..	23
Malaysia	19.9	25.5	32.1	5.2	7.9	18.3	20.0	0.4	160	160	38	58
India	14.9	13.7	20.3	3.9	4.1	12.2	12.7	1.2	157	0	2	5

Sources: (a) UNDP (2004), (b) US Patent and Trademark office web site: www.uspto.gov. (c) Haddad (2001) and (c) Lall (1999) computations based on UNCOMTRADE data 2000 and 1996 respectively, (d) UNDP (2002).
Note: (1) data refer to scientist and engineers (1996-2000), (2) data refer to 2001, (3) data refer to 2000, (4) data refer to 1985, (5) data refer to 1997.

Table 5- Distribution of R&D Institutional Units and Full– Time Equivalent (FTE) Researchers by type of R&D Institution in the Arab countries in 1996

	Number of R&D institutions				Number of FTE Researchers			
Country/ area	Public	University	Private	Total	Public	University	Private	Total
High income	23	3	4	30	473	219	23	715
Bahrain	3	1	0	4	27	59	0	86
Kuwait	11	0	4	15	334	83	23	440
Oman	6	0	0	6	56	26	0	82
United Arab Emirates	3	2	0	5	56	51	0	107
Average high income	0.77	0.1	0.13	100%	0.66	0.31	0.03	100%
Medium income	127	53	11	191	9633	4012	332	13977
Qatar	0	6	0	6	4	30	0	34
Saudi Arabia	19	28	2	49	308	538	0	846
Egypt	48	10	6	64	8074	2384	286	10744
Lebanon	11	0	0	11	93	112	0	205
Syrian Arab Republic	19	3	0	22	210	146	0	356
Iraq	12	3	0	15	729	662	0	1391
Jordan	18	3	3	24	215	140	46	401
Average medium income	0.66	0.28	0.06	100%	0.69	0.29	0.02	100%
Low income								
Yemen	7	0	0	7	204	66	0	270
Average Arab states	2.43	0.38	0.19		2.11	0.84	0.05	
Average high income	0.77	0.1	0.13	100%	0.66	0.31	0.03	100%
Average medium income	0.66	0.28	0.06	100%	0.69	0.29	0.02	100%
Average low income	100%	0	0	100%	0.76	0.24	0	100%
Average Arab states	0.81	0.13	0.06	100%	0.7	0.28	0.02	100%

Source: Adapted from ESCWA –UNESCO, Research and Development System in the Arab States: Development of Science and Technology Indicators 1998(E/ ESCWA/ TECH/ 1998/3)

Table 6 – Technology indicators: ICT in the Arab and world countries (1990–2002)

Country	population accessing/ Internet users (per 1,000 people) [a]		Telephone mainlines (per 1,000 people) [a]		Cellular subscribers (per 1,000 people) [a]	
Year	1990 [a]	2002 [a]	1990 [a]	2002 [a]	1990	2002 [a]
High income	0	777.4	823	1042	50	2178
Bahrain	0.0	245	191	261	10	579
Kuwait	0.0	105.8	188	204	12	519
UAE	0.0	313.2	224	291	19	647
Qatar	0.0	113.4	220	286	9	433
Average high income	0	194.35	205.75	260.5	12.5	544.5
Medium income	0	501.6	579	1238	3	1360
Oman	0.0	70.0	60	92	2	183
Saudi Arabia	0.0	64.6	77	151	1	228
Algeria	0.0	16.0	32	61	(.)	13
Egypt	0.0	28.2	30	110	(.)	67
Lebanon	0.0	117.1	155	199	0	227
Morocco	0.0	23.6	16	38	(.)	209
Syria	0.0	12.9	41	123	0	23
Tunisia	0.0	51.7	37	117	(.)	52
Occupied Palestine Territories	0.0	30.4	..	87	0	93
Libyan Arab Jamahiriya	0.0	22.5	48	118	0	13
Djibouti (low)	0.0	6.9	11	15	0	23
Jordan (m)	0.0	57.7	72	127	(.)	229
Iraq	Na	Na	Na	Na	Na	Na
Average medium income	0	41.8	52.64	103.17	0.43	113.33
Low income	0	15.6	25	74	0	119
Sudan (low)	0.0	2.6	3	21	0	6
Yemen (low)	0.0	5.1	11	28	0	21
Mauritania	0.0	3.7	3	12	0	92
Comoros	0.0	4.2	8	13	0.0	0.0
Average low income	0	3.9	6.25	18.5	0	39.67
Arab states	0.0	28.0	79	81	(.)	85
Average high income	0	194.35	205.75	260.5	12.5	544.5
Average medium income	0	41.8	52.64	103.17	0.43	113.33
Average low income	0	3.8	5.67	20.33	0	39.67
% of high income in Arab total		81%		68%		78%
% of medium income in Arab total		17%		27%		16%
% of low income in Arab total		2%		5%		6%
Advanced countries						
Norway	7.1	502.6	502	734	46	844
Sweden	5.8	573.1	681	736	54	889
USA	8.0	551.4	547	646	39	906
UK	0.9	423.1	441	591	19	814
Japan	0.2	448.9	441	558	7	637
Korea, South	0.2	551.9	306	489	2	679
Singapore	0.0	504.4	346	463	17	796

Source: UNDP Human Development Report (2004).

Table 7- I Basic and High Technology Infrastructure and TAI Arab and World countries (1992-1998)

Country/ Year	1992	1994	TAI and classification (1998)
	BASIC	HIGH	
Egypt	NA	0.27	0.236 - Dynamic Adopter
Iraq	NA.	NA	Na
Kuwait	1.45	0.16	Na
Libya	1.06	NA	Na
Oman	0.86	NA	Na
Tunisia	0.82	0.17	0.255 - Dynamic Adopter
KSA	1.08	NA	Na
Syria	1.02	0.07	0.240 - Dynamic Adopter
Yemen	0.18	NA	Na
UAE	1.41	NA	Na
Average Arab	0.985	0.1675	Dynamic Adopter
Algeria	NA.	NA	0.221
Sudan	NA.	NA	0.071 – Marginalized
Other Arab	Average		Total
Average Arab high income	0.968	0.17	0.51
Average Arab medium income	1.43	0.16	0.16
Average Arab low income	0.18	NA	NA
Turkey	1.49	0.31	Na
Singapore	1.64	1.39	0.585 – Leader
Korea, Republic	1.76	2.14	Na
Hong Kong	1.99	NA	0.455 - Potential leader
Malaysia	1.05	0.13	0.396 – Potential leader
Finland	2.64	2.40	0.744 – Leader
Sweden	2.95	3.26	0.703 – Leader
Japan	2.26	3.18	0.698 – Leader
USA	2.67	2.67	0.733 - Leader

Source: Rasiah (2002)

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